LAKE ANNA
SPECIAL AREA PLAN

March 2000

LAKE ANNA SPECIAL AREA PLAN COMMITTEE

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Purpose

The Lake Anna Special Area Plan is the result of a unique planning effort undertaken by the Boards of Supervisors of Louisa, Orange, and Spotsylvania Counties at the request of the Lake Anna Advisory Committee (LAAC). LAAC, created in 1994 by the three localities under the Joint Exercise of Powers provisions in the *Code of Virginia*, has been advising the three counties about Lake-related issues since the committee's inception.

This Plan is the culmination of the work of the Special Area Plan Committee appointed by the three Boards of Supervisors. The primary issue addressed in the Plan is the quality of the water in the Lake and its tributaries. A consistent regional approach is recommended for local action to preserve and protect Lake Anna's water quality. This approach recognizes the regional nature of the watershed and the local authority for implementing the recommendations. The Plan is submitted to the Boards of Supervisors to accept as a regional plan for incorporation into each local plan.

Major Findings

Data developed during the planning process include: population distribution and growth, water quality in the lake and its tributaries, land use, road capacity, soils, steep slopes, percentage of impervious cover, land cover, lots less than five acres, land values, and public services. These data were used in developing this plan and are presented in the plan text or the appendices. Major findings include:

- Development patterns of sprawl threaten the rural character, the environment, and the existing quality of life in the Lake Anna Watershed
- Land use practices vary throughout the Watershed
- Responsibility for on-going review of environmental conditions in the Watershed is unclear
- The environmental data base necessary for responsible and informed decision-making is not available
- River tributaries are impaired due to levels of pollutants; one has severe acid mine drainage
- The circumferential road system recommended when the Lake was created has not been completed
- Gas and petroleum transmission lines cross the Lake and the Watershed, posing a threat to public safety and the environment

- Public access to the Lake is limited
- Heavy metals data, though sparse, is cause for concern

Study Conclusions

Lake Anna is a valuable economic, recreational, and visual asset to the Commonwealth of Virginia and to the three counties in which it is located. It is essential that the value of this significant asset be protected and enhanced in all respects. Local and state government action and resources, combined with citizen education and action, are needed to preserve the desirable qualities of the Lake for both current and future generations. Acting now will prevent more costly and more extensive efforts in the future.

The original plan for managing the development around the Lake was prepared by Virginia Power in the late 1960s. The local governments did not adopt that plan. Without a governing plan, the resulting development has occurred at higher densities and with less open space than that recommended in Virginia Power's plan, even though building has occurred on less than half of the currently platted lots. Even without additional rezonings, the population in the Lake area would double if the currently approved development is completed. This represents a critical situation since a significant percentage of the land in the Watershed is unsuitable for septic fields.

These and other factors contribute to a real and growing concern for the quality of the water in the Lake. For example, the water quality in several streams that feed into the Lake is impaired. One of these streams is 1.2 miles up the Lake from the State Park swimming beach. Insufficient monitoring data exist to assess several aspects of the quality of the water in the Lake itself. Further, the differing approaches taken by the three counties to land use planning and stream protection do not assure that the most effective techniques are brought to bear consistently across the Watershed.

From an economic perspective, it is prudent for local and state funds to be invested in the Watershed. Tourism income and real estate values contribute significantly to the economies of the Watershed.

Public safety needs are sufficient in themselves to warrant governmental action. The existing network of roads that connect and interconnect around the Lake are woefully inadequate for the nature and frequency of use they receive. As the population increases, these roads will become even more unsatisfactory and hazardous for daily use. There is also a major concern about the adequacy of these roads as evacuation routes should an event at the plant, pipeline leaks, natural disaster, or some other cause require evacuation of the area.

The Lake Anna Special Area Plan Committee recommends that in implementing all of the recommendations made in the Special Area Plan that the Boards of Supervisors of the Counties of Louisa, Orange and Spotsylvania give first priority to the seven priority recommendations.

Priority Recommendations

I. Create a Lake Anna Watershed Overlay District in all three counties consisting of two tiers: Inner Ring and Watershed. The purpose of the Overlay District is to maintain the rural character of the area by implementing a cooperative, coordinated, consistent watershed program for Lake Anna.

   A. Develop, implement, and enforce uniform zoning, site plan, subdivision, and watershed management programs in all three counties, using consistent standards to ensure water quality.
   B. Evaluate all land use activities in the Overlay District primarily in terms of the effect on water quantity and quality.
   C. Maintain densities at a level that can be served by well and septic systems or require wastewater treatment systems to tie into a municipal system.

II. The Lake Anna Advisory Committee will track progress toward meeting goals of this plan, and prepare and submit annual reports on the progress.

III. Assure the conditions in the Lake and its tributaries are monitored and reported on an on-going basis.

   A. Institute on-going monitoring of the tributaries to detect nutrients and pollutants, with emphasis on impaired streams.
   B. Determine sources of fecal contamination and implement appropriate reduction strategies that respect the value of agricultural uses currently in place.
   C. Institute a water quality monitoring program in the Lake itself to determine presence of heavy metals, nutrients, and pollutants.

IV. Identify village centers and concentrate public service activities and commercial development in those centers. Provide public water and sewer services only within growth centers.

   A. Restrict services to within growth center (towns, villages) boundaries
   B. Prevent proliferation of private waste water treatment plants
   C. Require well casings to bedrock

V. Upgrade existing roadways to create a circular transportation route around Lake Anna to provide adequate lanes for towed boats and bicycles. Ensure roads provide safe evacuation routes.

VI. Develop plans to deal with potentially catastrophic situations related to gas and petroleum transmission lines and/or upstream dam breaks.

VII. Support state park improvements that are developed with adequate citizen participation in the decision-making process.

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II. Vision Statement

Lake Anna is a valuable natural resource and an asset to the Counties of Louisa, Orange, and Spotsylvania, Virginia Power, and the Commonwealth of Virginia. The Lake is valuable as an asset in many different ways - including recreational, economic, industrial, and civic to name a few. As a recreational facility, the Lake draws people from surrounding localities and states who enjoy the rural setting, the water quality, and general quality of life that exists in the Lake environs. As an economic asset, the watershed of the Lake contributes tax dollars to the local and state economies through real estate, property, and sales taxes, while providing both business and employment opportunities to residents of the three counties. As an industrial asset, the Lake itself provides a cooling area for the nuclear power plant, a major employer, located at the eastern end of the lake. As a community asset, inhabitants of the Lake Anna watershed contribute many hours to civic activities such as volunteer fire and rescue, water rescue and education, and service on various committees and task forces. The total of these assets mandate a cooperative and collaborative approach be taken to development in the watershed in order that the Lake remains an asset for future generations.

Thus, the Counties of Louisa, Orange, and Spotsylvania will, using a cooperative, coordinated approach, implement a master plan for the Lake Anna watershed that will maintain high water quality, reduce pollution from both point and non-point sources, protect the environment, maintain the rural landscape, manage growth, provide adequate public safety services and provide continued multi-purpose recreational opportunities for residents and visitors. This will be achieved by using the principles of sustainability, tools of growth management and other sound planning practices to reduce soil erosion and nutrient runoff, reduce litter, maintain open space, provide adequate habitat for wildlife and maintain maximum plant diversity, while providing the requisite public services.

III. Project Background

Introduction

The Boards of Supervisors of the Counties of Louisa, Orange, and Spotsylvania agreed to support the development of an inter-jurisdictional, comprehensive plan for the Lake Anna watershed in the spring of 1998. Each locality appointed three persons to serve on the Lake Anna Special Area Plan Committee and asked the Lake Anna Advisory Committee to appoint one person from each jurisdiction from their membership. The resulting committee requested the addition of a Virginia Power representative, for a thirteen-member committee. The group started work December 1998. Staff support was provided by the three local planning staffs and the three planning districts that serve the localities in the Lake Anna Watershed: Thomas Jefferson Planning District Commission, Rappahannock Area Development Commission, and Rappahannock-Rapidan Regional Commission.

The primary issue addressed in the Plan is the quality of the water in the Lake and its tributaries. A consistent regional approach is recommended for local action to preserve and protect Lake Anna's water quality. This approach recognizes the regional nature of the watershed and the local authority for implementing the recommendations. The recognition of Lake Anna as a regionally shared asset undergirds the plan.

Purpose

The Lake Anna Special Area Plan is the result of a unique planning effort undertaken by the Boards of Supervisors of the Counties of Louisa, Orange, and Spotsylvania at the request of the Lake Anna Advisory Committee (LAAC). The three counties created the LAAC under the Joint Exercise of Powers provisions in the *Code of Virginia* in the spring of 1994. The LAAC has been advising the three counties about Lake-related issues since the committee's inception.

A comprehensive plan is general in nature. It is not regulatory and does not contain laws and regulations. The Plan does, however, serve as the basis and rationale for zoning, subdivision, and site plan ordinances as well as other regulatory actions that implement the plan. This Plan contains a regional rationale for local action.

The Plan is submitted to the Boards of Supervisors to accept as a regional plan for incorporation into each local plan. Following incorporation, the localities are requested to proceed with the creation of an Overlay District and review and make appropriate revisions to the zoning, subdivision, and site plan ordinances.

In developing the Plan, the Committee agreed to the presentation of history and present conditions, a Vision, and Recommendations. The plan is developed along those lines, with key findings included with the Recommendations. Detailed data are available in the text of the report and the appendices.

Planning Process

The thirteen-member Lake Anna Special Area Plan Committee developed an outline and time line for the completed Plan. A key element in completing the Plan was the consistent interest and input from area citizens. To provide a context for the Plan, the Committee held a Visioning Forum early in the process, April 10, 1999, at Spotsylvania High School. The approximately 80 people who attended the Forum were welcomed by Senator R. Edward Houck, Delegate V. Earl Dickinson, and the Chairs of each Board of Supervisors.

The attendees were briefed on existing information about the Lake and then formed small groups to discuss their vision for the Lake area. The brainstorming elicited a wide variety of focus areas. Discussion was vigorous; conflicting views were debated; each group reached consensus. All ideas were brought together as broad topics, with the assistance of a facilitator. Each group reached consensus on priorities among the broad topics and reported back to the full group on the top three. All topic areas were brought forward as information in order to capture the richness of the people's vision for the future of Lake Anna. The Vision Forum resulted in the Vision Statement and a series of goals and objectives that provided a framework for future discussions. The Vision Statement can be found on page 1 of this document.

At a later public meeting to review the draft document, the public provided insight and constructive suggestions. Additional information gathered during the process and comments from posting the goals and objectives on the TJPDC web site resulted in some modifications. The final version of the goals and objectives are interspersed throughout the document in relevant sections.

The Committee also reviewed information pertaining to Rapid Watershed Planning and Better Site Design developed by the Center for Watershed Protection, and Conservation Planning for site development, a concept developed by Randall Arendt of the National Land Trust. York River Watershed Tributary Strategies were presented. Virginia Power plans were reviewed and a tour of the plant was arranged by the Virginia Power liaison.

In understanding the past, the Committee sought to plan for the future using the citizen-developed Vision as a guide. The contributions from the participants were vital and served as the basis for formulating the Plan.

Existing Studies

Five existing studies of the Lake Anna area have been completed since the Lake was created. They include:

- Virginia Power Lake Anna Plan (completed prior to Lake creation)
- County of Louisa Comprehensive Plan
- County of Orange Comprehensive Plan
- County of Spotsylvania Comprehensive Plan
- Report from the Lake Anna Advisory Committee

The Virginia Power Plan was foresighted and assisted in securing public and local government acceptance, but unfortunately was not implemented, nor was it adopted by any local government. The Lake was built and development began to occur under the differing land use and zoning ordinances in existence in the three Counties. A Summary of the Virginia Power Lake Anna Plan is included in the Appendices. Although the plan was not adopted by the localities, several recommendations of the plan have reappeared in the community and committee discussions.

The Report from the Lake Anna Advisory Committee is incorporated into the watershed planning section of this document. Summaries of each Comprehensive Plan are included in the Appendices. Louisa's 1993 Comprehensive Plan was amended in 1998 and is currently under review. The 1998 amendment calls for Louisa County to work with Spotsylvania and Orange Counties to develop a master plan for the Lake Anna area and to limit development densities until such time as the Plan revision is completed. The Orange County Plan was adopted in September 1999. The plan addresses the issue of non-point source pollution control, but includes limited information specifically about the lake. The future land use map shows the watershed to be located in an area designated as Agricultural or Open Space. The Spotsylvania plan designates the Lake Anna Resort District as one of six "planning districts" of the County to insure that development is in keeping with the natural character and beauty of the area.

Implementation

The "on-the-ground" implementation of the Lake Anna Special Area Plan will be the purview and responsibility of each local government, with advice from the respective local Planning Commission. The first step in implementation is the review and adoption of this Plan by each locality as an amendment to the existing local Comprehensive Plan. The second step is the creation of an Overlay District. Zoning, site plan, and subdivision ordinances in each County will be brought into conformance with each other and the goals of the Plan.

Legal Basis for the Lake Anna Special Area Plan

Section 15.2-2230 of the *Code of Virginia* requires localities to review their Comprehensive Plan every five years. This section provides for development of sub-area plans and inter-jurisdictional plans. The Lake Anna Special Area Plan meets these two objectives.

IV. Description of Lake Anna and the Watershed

Overview

Virginia Power created Lake Anna in 1972 to provide cooling water for the nuclear power plant located near the dam. The Lake itself is seventeen miles long and 1.5 miles wide, with about 200 miles of shoreline. The main body of the Lake covers 9,600 acres, with an additional 3,400 acres in cooling lagoons. When created, it took ten and a half months for the Lake to fill. Approximately 5,000 additional acres were purchased by Virginia Power, 1,075 of which contain the plant. The total construction cost was $1.3 billion, which includes plant, lake, dams, roads, and bridges. The Virginia Department of Game and Inland Fisheries stocks the Lake annually to continue the 5.5 million initially stocked fish population, consisting of thirty-three species of fish.

The Lake itself is publicly owned. Virginia Power owns the bottom and the shorelines. The original purpose of the Lake, to serve as a cooling basin for the nuclear power plant, continues. Access to the cooling lagoons is limited to lot owners and no adjacent commercial development is permitted. The main portion of the Lake (cold side of the plant) is public and is used for fishing, boating, swimming, and water-skiing.

Origins of Lake Anna

The original announcement to build the North Anna Power Station was made by Virginia Electric and Power Company (VEPCO), now Virginia Power, in 1967. Plans for creating the Lake were developed by Virginia Power, which subsequently built and now operates a nuclear-fueled power station above the outlet of the Lake. To help achieve public and local government acceptance of the lake's creation, Virginia Power prepared a land use plan for the Lake. Essentially the Plan proposed three public park accesses along the lakeshore, development controls to mitigate erosion and sediment control, and a unified approach to planning in the watershed. The stated goals of the Virginia Power Plan were to:

- Maintain water quality
- Maintain quality of the natural environment
- Preserve the rolling pastoral nature of the Lake landscape within the context of orderly growth and development.

Virginia Power's primary continuing interest is in the water quality and the temperature of the Lake. To that end, hydrilla growth and fish populations are routinely monitored and if a problem is seen in the fish indicator or hydrilla

monitoring, efforts are made by Virginia Power to further identify the problem and correct it.

Description of Watershed

The Lake Anna watershed is that portion of the landscape that collects and provides the water flow the lake**.** Map #1: The Lake Anna Watershed displays the watershed area, which is that area of land that collects water from rainfall and ground sources that flow into the lake. The Lake Anna watershed area covers 342 square miles or 218,880 acres.

For every acre of lake, there are almost seventeen acres of land. The number of acres in the watershed by county and the percentage of the total land in each county in the watershed are as follows:

Table 1. **County Portion in Watershed**

County	**Area**	**Portion of County**	**Portion of Watershed**
Louisa	125,580 acres	38%	57%
Orange	48,798 acres	22%	23%
Spotsylvania	44,482 acres	17%	20%
Total	**218,860 acres**		

The watershed is about twenty-nine miles long, extending from the main dam at the southeastern most point of the watershed to within the towns of Gordonsville (40%) and of Orange (50%) on the western boundary. At the widest point, the watershed is approximately thirteen miles wide, extending from the Town of Louisa to the Intersection of State Routes 522 and 20 to the north.

Given an average annual precipitation rate of 42 inches, this watershed produces an average annual water yield of 270 cubic feet per second inflow into the lake. This inflow is more than sufficient to maintain normal lake water levels under average conditions. 320 miles of streams flow through the watershed.

The watershed is divided into three smaller hydrologic units, numbers 06, 07 and 08. See Map #2: Lake Anna Watershed Hydrologic Units. Hydrologic Unit 06 includes those streams which drain into the North Anna River before it enters the lake and those streams that drain directly into the lake from the southwestern portion of the hydrologic unit. Hydrologic Unit 07 includes those streams in the northwestern portion of the watershed that drain into the Pamunkey River plus those streams that drain directly into Lake Anna on the north and southeastern portions of the unit. Hydrologic Unit 08 includes those streams that drain into Contrary Creek before it empties into the Lake. Dividing the large watershed into these smaller units allows one to better focus on potential problems by drainage source. Throughout the rest of

the plan these units will be referred to as the North Anna, Pamunkey and Contrary Creek units respectively. Table 2 shows the acreage in each unit and what portion of the total watershed it comprises.

Table 2. Hydrologic Units Comprising the Watershed

Unit	Area	Portion of Total Watershed
North Anna (06)	85,016 acres	38.84 %
Pamunkey (07)	119,897 acres	54.78 %
Contrary Creek (08)	13,947 acres	6.37%
Total watershed area	**218,860 acres**	**100.00%**

Source: Virginia Department of Conservation and Recreation
Division of Soil and Water Conservation, Richmond, Virginia

Regional Context

The Lake Anna watershed is a regional watershed, covering portions of three counties. Located within the three-county watershed are the Towns of Mineral and Louisa in Louisa County, and Gordonsville and Orange in Orange County. No towns are incorporated within the Spotsylvania County portion on the watershed.

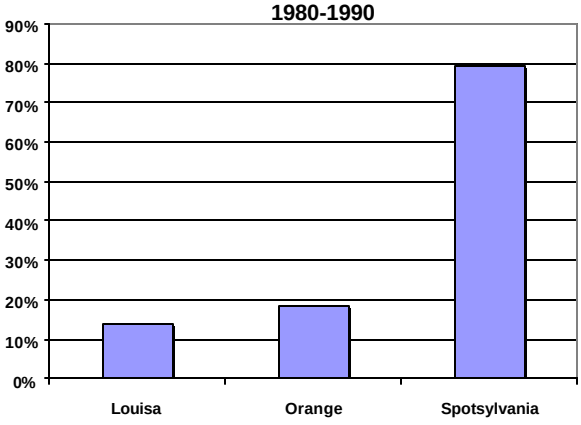
Of the three counties, only one, Spotsylvania County, is a Chesapeake Bay Act county. Under the Chesapeake Bay agreement among Maryland, Pennsylvania, the District of Columbia, and the Commonwealth of Virginia, localities in the area defined as "tidewater" are required to institute a higher level of nonpoint source pollution protection activity than other localities. Spotsylvania County is interested in having this sub-area plan assist the county in meeting the requirements for Comprehensive Plan conformity with the Bay Act. The three counties each has its own Comprehensive Plan, Zoning, Subdivision, and Site Plan Ordinances. This Plan is the first time the three localities have come together to consider a unified approach to planning in the Lake environs.

V. Data Presentation, Interpretation and Discussion

Demographics

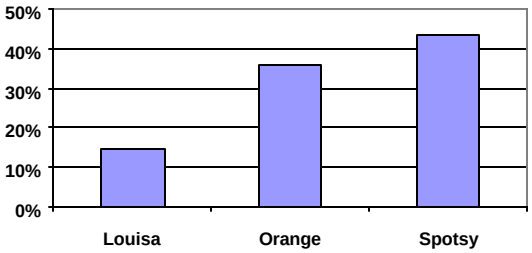
Charts 1 and 2 below reveal a higher percentage increase in the Orange County watershed population as compared to the countywide rate. The increase in Louisa is approximately the same in or outside of the watershed. In Spotsylvania, the increase within the watershed is about half that of the county at large. These percentages are very general in nature, given the fact the Census block boundaries change with each census, making sub-county estimations less accurate. It does give a sense of comparative rates of growth within the Lake Anna watershed portion of the three county area compared to growth experienced throughout each county.

Chart 1: % Change in County Population 1980-1990



Source: Weldon Cooper Center

Chart 2: Watershed Tracts Population: % Change 1980-1990



Land Use Patterns: Local

LOUISA COUNTY EXISTING LAND USE

Zoning immediately around the Lake is residential, with 40,000 square foot lots permitted by right. If public water and wastewater treatment is available, lot size may decrease to 10,000 square feet. There are fifty existing subdivisions in the Inner Ring, with nearly 3,700 lots platted, of which approximately 1,500 are improved. In many instances, the land is unsuitable for septic systems and wells. The remaining watershed is primarily agriculture and conservation, with ten acre lots allowed and seven division rights for twenty-one acre lots.

Two towns lie within the watershed, though on the periphery: Louisa and Mineral. Mineral has seen little growth in the last ten years; the Town of Louisa has seen moderate growth. Both towns have mixed land uses from business/industry to large lot residential.

Agriculture, forestry, and conservation land uses are, by acre, the most prevalent in the watershed. Forestry is a major component of the Louisa County economy, followed by agriculture.

ORANGE COUNTY EXISTING LAND USE

Orange County, with the least shoreline but 23% of the watershed land area, is primarily zoned agriculture, which allows two acre minimum lots. Growth in the watershed is mostly in the Gordonsville and Orange areas.

Most of the land use in Orange is agriculture or open space, which contributes to the economy, the environment, and the general sense of rural character so important to the residents and participants in the visioning session. The new Comprehensive Plan divides agriculture into Agricultural, Rural and Agricultural Conservation. Most of the watershed is in the latter category, which includes farmland, forest and open space, as well as scattered houses, small businesses and other uses incidental to rural living.

SPOTSYLVANIA COUNTY EXISTING LAND USE

The Spotsylvania Comprehensive Plan was adopted in 1994, with a recommendation to conduct a sub-area plan for the Lake Anna area. The Spotsylvania Lake Anna Resort District seeks to insure that development that occurs around Lake Anna is in keeping with the natural character and beauty of the area.

A few commercial nodes exist in the watershed, with the dominant land use being single family residences on one-acre lots along the shore and two to five acre lots inland. All housing units are on individual well and septic; no public water or sewer serves the area.

Approximately 30%-40% of the currently platted lots are developed, while 60%-70% of the land is in large tract farms. Agricultural zoning allows two acre lots in the County. To use the “resort residential” category of land use, a rezoning is required, at which point standards designed to protect the rivers, streams, and lakes must be met.

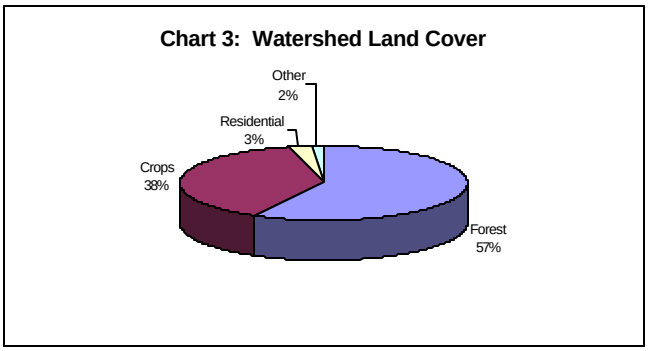
Land Use: Inner Ring

For the purposes of this study, the watershed was divided into two sections: the Inner Ring, which is adjacent to the lake, and the Watershed, which encompasses both the inner ring and the remainder of the watershed. These two areas are delineated on Map #3: Lake Anna Watershed with Inner Ring.

Land use within the Inner Ring is primarily residential in nature, with one major industrial site, the Power Plant. Small commercial areas, eight private marinas and four private campgrounds are on the Lake. The State Park, also on the Lake, is located in Spotsylvania.

LAKE ANNA STATE PARK

People visit the park to swim, hike, launch boats, picnic, and attend programs. In the mid-1990s total park attendance peaked, reaching over 180,000 visitors in 1997. In 1998, attendance decreased to about 142,500 persons. The beach is the destination for about 20% of the visitors, with about 27,000 visitors in 1998. Attendance at interpretive programs has increased every year. Picnic reservations have remained around 50-60 per year. The budget in 1998 was approximately $128,000; revenues that same year totaled approximately $180,000.



In 1999, the State initiated plans to expand the park facilities to be a "Destination Park" with a conference center, lodge, golf course, and expanded launching facilities. The project met with a great deal of citizen opposition. Meetings with state officials have indicated an interest on the state's part to re-examine the feasibility and desirability of its facility expansion plan.

Land Use: Watershed

LAND COVER

Of the acreage in the watershed, 57% is forest, with 34% covered with deciduous forestland and 23% covered with mixed forestland. 38% is covered with cropland and pasture. Only 3% of the land is covered with residential uses. See Map #4: Lake Anna Watershed Land Cover.

These land cover data come from satellite imaging, done by the United States Geological Service (USGS), provided in the "BASINS" GIS data. The limitations of

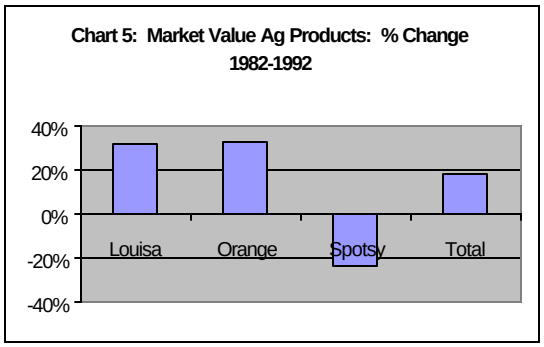
satellite land cover imaging are that the images do not pick up residential uses, particularly if the subdivision has many trees. When the mapping is overlaid with platted subdivisions, the picture changes within the Inner Ring, but holds generally true for the entire watershed, with the exception of the towns.

Land uses intensify as one moves from the outer reaches of the watershed to the Inner Ring, with the exception of several town areas on the outer watershed boundary. These towns are more densely developed with mixed uses. Towns within the watershed include Orange, Gordonsville (both in Orange County), Mineral, and Louisa (both in Louisa County). No incorporated towns are contained within the watershed portion of Spotsylvania County.

SOIL AND SLOPE CONSTRAINTS

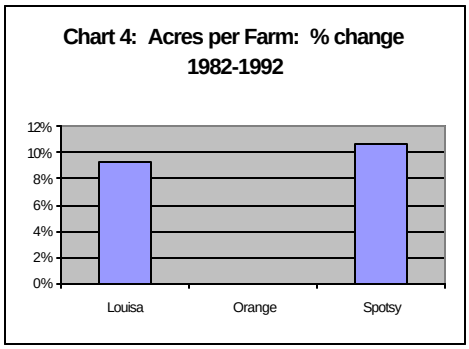
Shown on Map #5: Lake Anna Watershed Soil Constraints for Septic Field Operation, 82% of the land has moderate limitations for septic suitability; 15% has severe limitations. Only 3% of the land have only slight limitations for septic fields. Properly designed and maintained septic systems are usable in moderately constrained soils. Additionally, as shown on Map #6: Lake Anna Watershed Steep Slopes, six percent (6%) of the land is in steep slopes (>15%).

AGRICULTURE



The number of farms and total acreage in farming has decreased, as has the number of farms receiving more than $100,000 per year in sales. During the same time, the value of the farmland has increased.

The most recent data available are from the year 1992 and these data are only available on a countywide basis, limiting their applicability to the watershed. The number of farms in all three localities has decreased from 1,264 in 1982 to 1,059 in 1992, a decrease of 20% in Louisa and Spotsylvania and 9% in Orange. The average acreage per farm increased 8% in Louisa (194 to 212 acres), 14% in Spotsylvania (187 to 207 acres), and remained the same in Orange for the same period of time. Total land in cropland decreased significantly in Spotsylvania, slightly in Orange and Louisa.



ECONOMICS OF AGRICULTURE

The value of agricultural products sold increased overall, with Spotsylvania showing a decrease in the value over the ten year period, while Louisa and Orange each experienced about the same percentage increase. These values are in current, not constant, dollars. Agriculture, while not the major factor in the local economy compared to other industries/businesses, contributes to the rural character.

The number of farms with sales greater than $100,000 decreased in Louisa (-2) and Spotsylvania (-12), but increased in Orange (+2).

The land and building value per acre increased 33% in Louisa, 39% in Orange, and 55% in Spotsylvania during this period. In part this reflects the pressure for development of farmland, particularly in Spotsylvania.

FOREST LANDS

Map #7: Lake Anna Watershed Forested Land Cover indicates forestlands. Forestlands provide the most efficient non-point source runoff control. By holding the water in the root systems and gradually releasing it, the nutrients are filtered out before the water reaches the body of water into which it flows.

Louisa and Spotsylvania Counties have instituted Forestal Districts along with Agricultural Districts resulting in acreage that is protected in this manner. To utilize this tax benefit and resource protection, a landowner petitions the locality to place at least 20 acres in Agricultural/Forestal use. The land cannot be developed while in such a district and the owner receives a decrease in the valuation of the property, resulting in lower taxes. Should the owner wish to remove the land from these districts, he or she must petition the County to be released from the district and pay roll back taxes for the previous five years, based on full valuation of the property.

SUBDIVISIONS

There are over 100 subdivisions in the watershed. It is estimated that one half of the platted lots are yet to be built on. Private roads serve most of the subdivisions.

SCHOOLS

Louisa County has three schools in the watershed: one elementary school, one middle school, and one high school. All schools have seen an increase in school population since 1980.

Two schools are located in the Orange County portion of the watershed: one elementary schools and one high school. The school population in the elementary school has remained stable from 1990 to 1998. The high school has increased in numbers of students. Spotsylvania has no schools located in the watershed.

TRANSPORTATION

Land transportation is limited to private vehicles. No transit or passenger rail serves the area. One U. S. Route, 522, traverses the Lake area, crossing the Lake at the northwest end. U.S. 522 lies in a northwest/southeast direction, from Mineral northwest to the intersection of Route 20 at Unionville. The remaining road network consists of state primary and secondary roads. All roads are the responsibility of the Virginia Department of Transportation (VDOT).

Vehicle counts and capacity measures conducted on these roads have not earmarked them for improvement due to levels of use. What has happened to the road network is that, as the paved area was widened, the shoulders were diminished as all the work was done in the existing rights-of-way. VDOT has a policy of limiting improvements to areas where the landowner donates the rights-of-way, which, in some cases, restricts widening.

Residents and other users of the road network experience unsafe conditions when encountering wide loads such as lumber trucks or large towed boats. With a diminished shoulder, there is not a safe pull-off from the road to allow comfortable passage.

PUBLIC SAFETY

Map #8: Lake Anna Watershed Fire and Rescue Districts illustrates coverage by local squads. Some subdivisions, but not all, are served by dry hydrants, allowing fire protection using lake water. The subdivision road system, consisting primarily of private roads developed at lower standards than state requirements, is sometimes stressed when the fire services are required.

The three law enforcement agencies (VDGIF in cooperation with the Counties of Louisa and Spotsylvania) have a mutual aid compact, allowing officers to cross county lines to assist as needed. On the Lake itself, the Virginia Department of Game and Inland Fisheries patrols the Lake. This is done with one resident employee and officers from other areas as necessary. The Department rotates enforcement people on the lake from one location to another as the level of activity demands.

The Coast Guard Auxiliary provides boat inspections, boating courses to help promote boating safety, and provides help when boaters experience trouble.

VIRGINIA POWER NUCLEAR POWER PLANT

Unit One of the Power Plant came on line in 1978, Unit Two in 1980. The plant site covers 1,075 acres and was built for an estimated $1.3 billion. Both units were shut down for refueling in 1998 and came back on line in the same year. Two pads within the plant area can be used for spent fuel and high-level radioactive waste, for which the Plant is licensed. Two casks were stored in 1998 in July and September.

Hydroelectric generators are in operation at the main dam. The smaller unit operates throughout the year and requires a minimum flow rate of 40 cubic feet per second. The larger unit operates when the lake level exceeds 250 feet mean elevation.

In 1997 a fully evaluated emergency exercise was carried out in conjunction with the Commonwealth of Virginia and the counties inside of the Ten-mile Emergency Planning Zone. The Nuclear Regulatory Commission deemed it a successful exercise. Over 200 persons received training through the exercise.

Virginia Power is a major employer, employing approximately 900 full time persons and over 90 core contractors. Tax revenue for the Power Plant is paid to Louisa.

Concerns were raised by a Committee member about the wisdom of encouraging development near a nuclear facility. The Committee, while cognizant of the potential, did not move to change the existing plans and recommendations because of history and existing conditions.

Water Quality

PRESENT CONDITIONS

A striking feature of the goals for the future put forward by the groups of attendees at the Lake Anna Visioning Forum was that almost all of the eighty or so attendee's lists were topped by high water quality. In order to know how best to achieve it, however, we need to know what the water quality is now. Unfortunately, data for the lake itself is very limited.

SURFACE WATER

Monitoring Stations

The Virginia Department of Environmental Quality (DEQ) has ten quarterly water quality monitoring stations in the watershed. These are shown on Map #9: Lake Anna Watershed 1998 Impaired Streams and DEQ Monitoring Stations. None of the stations is located on the lake. The Ambient Water Quality Monitoring (AWQM) Program monitors the lake every five years, with two sets of samples taken so far. There had been a station, which was sampled monthly, a couple of miles downstream of the lake (at the Rt. 658 bridge), but it was closed in 1994. The nearest regular monitoring station (also monthly) now is at the Rt. 30 crossing at Hart Corner, 27 miles downstream of the Rt. 658 station. The York Watershed Council has three monitoring sites on the lake as well as five sites on its tributaries. They have taken eight grab samples since September 1997. However, their data were not available in time for the preparation of this document. Also, they do not monitor for as many parameters as DEQ does, including some of potential importance to Lake Anna, such as fecal coliform counts.

The only other entity monitoring on Lake Anna is Virginia Power's North Anna Nuclear Power Station personnel. From 1973 to 1985, they measured a variety of physical, chemical, and biological parameters, culminating in the *Section 316(a) Demonstration for North Anna Power Station* report in 1986. The Virginia Water Control Board accepted their results as a successful demonstration that the operation of the power station had not appreciably harmed the biological community. A reduced monitoring program was then approved and has continued to monitor temperature, the fish community, and the hydrilla (an invasive, non-native aquatic plant) population in the lake.

Water Gaging Stations

No water quantity gaging station exists within the Lake Anna watershed. The nearest one is at the Rt. 30 crossing of the North Anna River at Hart Corner, below the dam. A gage had been sited at the Rt. 601 crossing of the North Anna River (between the dam and the Rt. 658 crossing, near Partlow), but was discontinued in 1995. A third gage had existed near Doswell (upstream of Rt. 1 and several miles upstream of the Hart Corner station). The longest operating gage along the North Anna River, it had begun operating in 1929, was discontinued in January 1987, and then was reactivated for one additional year in October 1987.

The lack of gaging stations in the watershed makes it difficult to correlate water quality with water quantity, which in turn makes it more challenging to determine whether water quality problems such as fecal coliform concentrations are due to direct inputs or to stormflow runoff.

It is imperative that sufficient monitoring be conducted on the Lake and its tributaries in order to protect the health, safety, and welfare of all users of the Lake. The ever-increasing use of the Lake, particularly for fishing and swimming, must continue to be safe. Monitoring programs should include gaging water flow, testing for nutrients, pollutants and heavy metals, and reporting the results to the public in a comprehensive and comprehensible manner.

Water Quality Stations

DEQ data for the ten surface water monitoring stations in the watershed, the two stations downstream, and the AWQM stations were analyzed for nutrient concentrations, suspended solids, pH, metals concentrations, and fecal coliform counts. These measurements of water quality are ones that are often found to be of concern, and can indicate habitat, aesthetic value, and human health problems. The measurements are considered in detail in the subsequent sections. The number of stations has decreased from six in 1991 to four in 1996 due to budget constraints. Stations in the North Anna arm (reported as Rt. 719 in 1991 and Rt. 718 in 1996), upper mid lake, mid lake, and 100 yards upstream of the dam were retained. Downstream stations have decreased from two to one, probably for similar reasons. Data vary by frequency and components by tributary for reasons unknown at this time, budget constraints being most likely.

Data from Virginia Power were also examined. These included the 1973-1985 data on nutrients, pH, metals, and turbidity from the *Section 316(a) Demonstration for North Anna Power Station* (1986), as well as the biological studies from both that report and the *Environmental Study of Lake Anna and the Lower North Anna River: Annual Report for 1997 Including Summary of 1995-1997* (Virginia Power, 1998). Virginia Power reported data from nine stations in the Section 316(a) report, but two were only sampled in 1984 and 1985, and three others were sampled for only part of the parameters prior to 1984. All were sampled monthly.

Data from all sources are very limited and not consistently developed or reported. The State has, however, developed a list of "impaired" streams. These are streams that exceed pre-determined limits. Of ten Lake Anna tributaries, five are on Virginia's 1998 Clean Water Act Section 303(d) impaired waters listing. Map #9: Lake Anna Watershed 1998 Impaired Streams and DEQ Monitoring Stations locates the streams in the watershed that have been so designated.

Being on the 303(d) list means that TMDLs (Total Maximum Daily Loads) will have to be developed for these streams by 2010. In a TMDL, the sources of a specific pollutant are identified, and a determination is made of how much each would have to be cut back in order for the waterway to meet state standards. A cleanup plan is then devised.

Fecal Coliform Concentrations

Of the measurements of water quality examined, the most notable indicator of a water quality problem was the concentration of fecal coliforms in Lake Anna's tributaries. Fecal coliforms are bacteria found in the intestines of warm-blooded animals which are often used as an indicator of contamination from fecal matter and the possible presence of pathogens, or disease-causing microorganisms.

Eight of the ten Lake Anna tributaries that DEQ has been monitoring have exceeded the state secondary contact (fishing and boating) fecal coliform standard of 1000 counts/100 mL at least once in the last few years. Two of the eight, the North and South Forks of Hickory Creek, only exceeded the standard during a major storm in 1995 (the same one that caused Madison and Greene Counties to be declared national disaster areas due to flooding).

The remaining tributary, Goldmine Creek, exceeded the state fecal coliform standard three times in a four-year period (16 samples) from 1993-1997. Although this was insufficient for it to make the 303(d) list in 1998, the change in criterion in 2000 from a statistical method to a straight 10% of samples exceeding the standard may mean that it will be listed in the next round.

The absence of regular sampling is of concern, particularly due to the presence of a swimming beach at Lake Anna State Park, 1.2 miles downstream from one of the impaired tributaries. Fecal concentrations are generally correlated to higher flows. However, what data is available indicates enough exceedances in normal flow conditions to warrant a more systematic monitoring program. In 1994, shortly after the discontinuation of the Rt. 658 station, DEQ changed its fecal coliform counting methodology from membrane filtration to the most probable number method, a statistical method. The frequency of reporting of high fecal coliform counts increased greatly after the change in methodology.

Sources of fecal coliforms can include livestock, wildlife, failing septic systems, and pets, as well as a variety of sewer-related causes. On lakes and other navigable waters, waste from boats can also be an issue. Determination of the sources may well involve a combination of land cover analysis, stream walks, genetic testing of the coliforms, modeling, and common sense.

Methods of lowering fecal coliform concentrations depend on the source. Management measures can include:

- public education;
- fencing cattle out of streams/giving them an alternate water source;
- required pumpout of septic tanks;
- careful siting of future septic tanks;

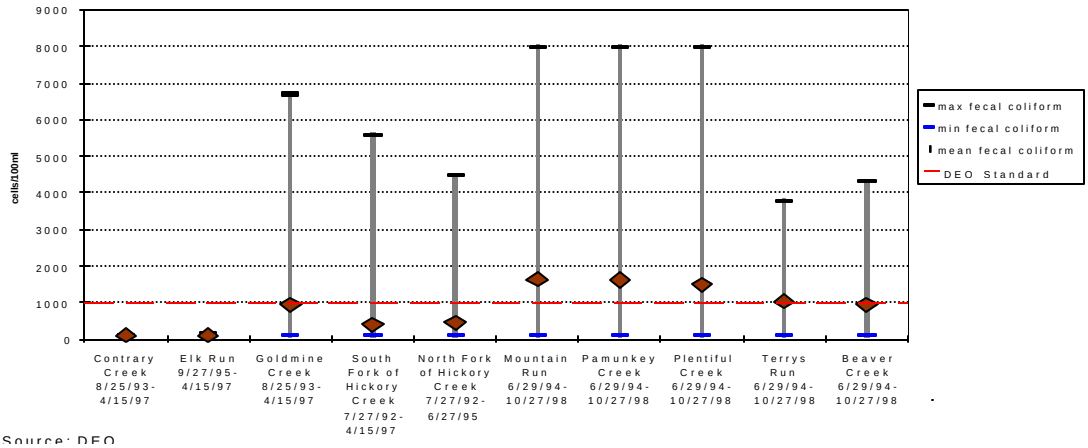
- wildlife management;
- pooper-scooper laws;
- on the lake, provision and enforcement of the use of well-maintained marina pumpout facilities.

With existing wastewater treatment plants in Gordonsville, Louisa, Orange and on the lake it is important to recognize that existing plants need careful monitoring to ensure water quality standards are being met and that any additional treatment facilities meet stringent parameters.

pH

pH is a measure of acidity/alkalinity, ranging in value from 0 to 14. Most plants and animals have a limited pH range, usually somewhere around neutral or 7, in which they can survive. If pH is very low (acid) or very high (alkaline) the biologic

Chart 6: Fecal Coliform Levels in Lake Anna's Tributaries



Source: DEQ

community of the affected stream or lake may be limited to a few kinds of bacteria. Low pH also increases the solubility of many kinds of metals, which can be toxic. High pH can increase ammonia concentrations, which can also be toxic.

Only one of Lake Anna's tributaries, Contrary Creek, violated DEQ's pH standards (was outside of the 5-9 range) during the period studied. However, that violation was quite serious, as the pH in Contrary Creek did not once get as high as the standard. It also appears from the DEQ data that the creek may have serious problems with high metals concentrations, but only one measurement of those was made during the 1993-1997 time period studied. Contrary Creek is impacted by acid mine drainage (AMD) from a number of abandoned mine sites in its watershed. According to the Louisa County Soil Survey, there are 346 acres of mine dumps in the watershed.

A failed attempt at remediation in the early 1970s has kept Contrary Creek off the 303(d) list, as states have not been held responsible for cleaning waterways which were the subject of previous failed attempts. However, changes in regulations make it likely that Contrary Creek will be on the 2000 list. Improvements in AMD remediation techniques since the 1970s are cause for hope that water quality in Contrary Creek may be improved.

It should be noted that the dilution effect of Lake Anna raises the pH of Contrary Creek considerably by the time it reaches the Rt. 652 bridge, which is where Virginia Power's monitoring station was located. Readings continue to be lower here than the rest of the lake, however, which is of some concern due to the metals data.

Metals

Effects of high concentrations of metals can include human physical, developmental, and reproductive effects, as well as mortality at very high levels. Certain metals that are nutritionally required in small quantities, such as zinc and copper, are able to be metabolized by fish, but may be toxic to other types of aquatic organisms. Other metals, such as lead, cadmium, and mercury, can be toxic to fish as well, and to other animals (including people) who eat sufficient quantities of the fish. Of the metals, only mercury bioaccumulates, but fish consumption advisories have been listed (on the Listing of Fish and Wildlife Consumption Advisories, online at http://fish.rti.org/) for other metals, particularly lead.

Metals data for Lake Anna are sparse and consist of the Virginia Power measurements, one set of surface water measurements for seven of the tributaries from DEQ, one set of sediment measurements from DEQ for each of the tributaries (two sets for three of them), and two sets of sediment measurements from DEQ for the lake. Additionally, the Virginia Power data are of limited use because surface water quality standards for aquatic life for several metals are dependent on hardness (the sum of polyvalent cations, such as calcium and magnesium, dissolved in the water. This is expressed as a $CaCO_3$ concentration), and Virginia Power did not measure hardness. No data is currently available on metals concentration in fish or other animals in Lake Anna, but the U.S. EPA has just completed sample collection for a fish tissue study (part of a random lake sampling program), which is expected to be available in the latter part of 2000.

What data are available warrant concern. Indications that copper, lead, and zinc concentrations exceed limits in many of the samples form the basis for this concern. Metals toxicity levels are related to hardness, which was not measured at the same time, location, and depth. Too few samples were taken to determine the extent of the sediment problem, but the samples taken indicated that advisory standards were exceeded for lead and copper for Contrary Creek, for lead in Elk Creek and for Zinc in Lake Anna near the dam. A full explanation of the findings is found in the

appendices. Given the amount of previous mining activity in the watershed it is wise to pursue this question to protect the health, safety, and welfare of the users of the Lake and to insure accurate information is available on which to make conclusions to avoid unnecessary alarm.

Nutrients

Excessive levels of nutrients can cause algal blooms, or excessive algal growth. This is an environmental problem, as nutrients can lower the dissolved oxygen levels upon which many aquatic animals depend. It is also an aesthetic and recreational problem. The two nutrients that are most likely to limit plant growth are nitrogen and phosphorus; in freshwater, phosphorus is usually the only limiting nutrient.

Nitrates (NO_3) and nitrites (NO_2) can also be a human health problem. Excessive nitrite concentrations may cause methemoglobinemia (blue baby syndrome) in bottle-fed babies, and also may produce a serious condition in fish called "brown blood disease." As nitrates may be converted to nitrites, both chemicals should be monitored.

Plant nutrients carried in waterways are often derived from fertilizers, detergents, and animal and human wastes, but can also be found in rocks, soils and dead plant matter. Phosphorus easily attaches to soil and is often carried into waterways by erosion.

Although nutrient concentrations overall do not appear to be a serious problem in the Lake Anna watershed, increased development could raise nutrient levels, so attention should continue to be paid to nutrients. Preventive measures could avoid the need for corrective measures later. Many management measures for nutrients are available. Major categories include:

- cutting down application of fertilizers;
- erosion prevention;
- runoff capture/filtration;
- better management of human/animal wastes.

With the exception of fertilizer management, these methods are covered in more detail in later sections.

Total Suspended Solids

Total Suspended Solids (TSS) are all of the particles suspended in the water, including sediment and algae. High quantities of suspended solids can be both an aesthetic and a habitat problem. Habitat problems include:

- blocking light to the lower levels of a water body, thereby limiting growth of bottom-dwelling plants;
- clogging fish gills and the filters of filter-feeding organisms, such as mussels;
- interference of settled sediment with the reproductive success of stream-dwelling fish that need clear rocks to spawn, such as chub;
- reduced habitat due to settled sediment for many insect larvae, such as mayflies and caddisflies.

As already mentioned, sediments and plant matter can carry nutrients into the water.

It should be kept in mind that while TSS levels are not high enough to be the cause of habitat problems in and of themselves, they may still contribute to elevated phosphorus levels. Also, a sedimentation rate too slow to create TSS problems may still, over time, lead to the filling of the lake (see the Erosion section starting on page 26 for more information). Many methods of sediment control are covered in the Tools of Watershed Protection section of the Appendices.

ECOLOGICAL ASSESSMENT

As part of the Section 316(a) report, Virginia Power studied temperature, phytoplankton, zooplankton, benthic macroinvertebrates, fish, and waterfowl. The 1997 annual report and 1995-1997 summary included data on temperature, fish, and hydrilla.

Temperature

Lake Anna, as is typical of lakes in seasonal climates, undergoes thermal stratification in the summer. Before operation of the power plant began, the summer epilimnion (warm, oxygenated water at the surface of the lake) of the lower lake was 2 to 5 meters (m) deep. Once the plant began operation, this layer increased in depth, apparently because of greater mixing as a result of the discharge and intake of the power plant. The 1997 data indicated that the depth of the transition zone (metalimnion) was 8-10 m in June and had increased to 13-15 m in August. The lowest depth at which oxygen levels capable of sustaining fish were found also increased from about 5 m to about 9 m upon the beginning of plant operation. This resulted in an increase in fish habitat of about 27%. Virginia Power estimated that the power station contributes about an additional 10% of the heat that would naturally enter the system in the summer; the percentage of winter heat was not given.

Plankton

Phytoplankton are the primary producers of organic material in the Lake Anna aquatic community. Phytoplankton abundances gradually increased from 1972 through 1976, increased substantially in 1977, decreased substantially in 1978, and increased gradually through 1985. Virginia Power noted that this is a common pattern for new reservoirs. Phytoplankton are most abundant in the upper lake and least abundant in the lower lake, also a typical reservoir pattern, and have a community structure similar to other reservoirs. No nuisance growths of algae were identified during the 316(a) study.

Zooplankton populations were found to be stable and moderately diverse following the transition years of 1972-1975. The upper lake has the most abundant and diverse population, which was still gradually increasing in 1985, and which is a typical reservoir pattern. Seasonal peaks in the mid and lower parts of the lake shifted from July to April-May once the power plant began operation. No unusual or nuisance zooplankton populations were observed. Overall, zooplankton populations and patterns were found to be typical of temperate eastern reservoirs.

Benthic Macroinvertebrates

The filling of the lake resulted in a sharp change in the community of invertebrates dwelling on the bottom. Shifts from riverine to lacustrine species occurred, and abundances fluctuated through the 316(a) study period. The end of the study period in 1984-85 saw a gradual increase. Taxa identified increased from 111 in pre-operational years to 124 in operational years, with 60 of the 124 being new taxa. In 1979, the Asiatic clam took hold; its numbers increased sharply until 1981, when its population stabilized. By 1985 the benthic community was found to be similar to other temperate reservoirs.

Fish

From 1975 through 1985, fish of 39 species in 12 families were found in Lake Anna. The community structure was relatively stable over the study period, but the biomass of fish increased sharply in 1985 due to an increase in introduced threadfin shad and in gizzard shad. Shad, carp, and sunfish accounted for an average of 86% of the fish by weight. Lake Anna was found to have a greater percentage by weight of predatory fish than other reservoirs; in 1984-85, Lake Anna had 15% predatory fish, as compared to 2% for 173 reservoirs in the United States. Lake Anna also had a greater percentage of plankton feeders (52% vs. 38%) and a lower percentage of bottom feeders (33% vs. 50%). These differences were thought to be largely due to the introduction of the threadfin shad, which were brought in to provide forage for sport fishes and which could not survive without the heat provided by the discharge from the power station. Compared to other reservoirs (even other thermal reservoirs), Lake Anna was found to have a greater total standing crop of fish. Major

indigenous species in 1985 included largemouth bass, bluegill, and gizzard shad. Common carp numbers had been variable. Black crappie had been in decline but increased in 1985, which was thought to be due either to the threadfin shad introduction or to the construction of underwater habitat by Virginia Power. Yellow perch, a cool water species, had been largely replaced by white perch, a warm water species. Pumpkinseed sunfish, which feed on aquatic insects, had retreated to the upper lake and been largely replaced by redear sunfish, which feed on Asiatic clams. The most important introduced species were striped bass, walleye, and the threadfin shad.

The 1997 Virginia Power Annual Report showed a slightly lower diversity than the 316(a) report, with 33 species in 12 families reported for 1981-97. Twenty-six species were collected in 1997. In 1997, the dominant species in the lake by weight as captured by gill netting (which captures fish found deeper in the lake) was striped bass, followed by channel catfish and gizzard shad. In the Waste Heat Treatment Facility (WHTF), the most dominant species by weight were gizzard shad, channel catfish and largemouth bass. The dominant species by weight as collected by electrofishing (used for fish that live near the shoreline) was bluegill for both the lake and the WHTF. Common carp was second in the lake and redear sunfish was second in the WHTF. Two new species, blue catfish and green sunfish, were collected in the 1995-97 period. 1981-87 data indicated no obvious trend in number or weight of fish captured by electrofishing. Gill net data, however, showed a threefold increase in the weight of fish collected over the period, although the number of fish collected was nearly the same in 1997 as in 1981. The fish community in Lake Anna may still be maturing, but overall seems to indicate a healthy reservoir.

Waterfowl

Lake Anna provides a major inland stop for migratory waterfowl along the Atlantic Flyway, as well as providing habitat for migratory and residential waterfowl. In sightings between 1976 and 1984, approximately 78 species of birds were observed. In 1984, the most abundant were ring-billed gull, American coot, mallard, and Canada goose.

Hydrilla

Hydrilla is an exotic submerged aquatic plant that is able to spread rapidly through fragmentation. In 1994, triploid grass carp were introduced to control the hydrilla population in Lake Anna. This introduction was followed by a population crash of hydrilla in 1995, but interestingly, hydrilla disappeared from within plots fenced to exclude carp as well as from the rest of the lake and WHTF. Virginia Power staff hypothesized in the 1997 report that this was due to silt and turbidity in 1995. The following two years saw some regrowth of hydrilla, but plants were short and

stunted, with the exception of the exclusion plots where they were lush and healthy. This would indicate that the reduction in hydrilla in this case was probably due to the grass carp.

GROUNDWATER

Little information on groundwater quality or quantity is available for the Lake Anna watershed. The only study done to date on groundwater quality was the Louisa County Water Testing Program undertaken in 1992 as a cooperative effort between the Thomas Jefferson Planning District Commission and the Service Training for Environmental Progress program at Virginia Tech. This study presents enough data of concern that similar studies should be carried out in all localities, as well as more defined study in Louisa County

One hundred and nineteen wells were tested from a cross-section of land uses, including 29 wells in the Lake Anna watershed (16 of which were in the Inner Ring). Some preliminary work was also done in Louisa on groundwater quantity. As part of the Louisa County Water Quality Management Plan and Groundwater Study in 1997-98, Louisa County Health Department well completion data was entered into a database and analyzed for characteristics such as well yield and well casing length. Unfortunately, it was not possible at that time to locate the wells with more precision than by tax map.

Groundwater Quality

Groundwater is important in the three counties as most of the residents and commercial enterprises depend on groundwater as their source of water.

Of the 119 wells tested by the Louisa County Water Testing Program in 1992, 29 wells were in the Lake Anna watershed. Of those 29, 16 were in the lakeside area, 18 were residential (with 11 being one-acre or small lots, six being 1-5 acre or medium lots, and one unclassified), ten were on farms, and one was at a quarry. Wells were tested for pH, total and fecal coliform presence, metal (lead, copper, zinc, manganese, and iron) concentrations, anion (sulfate, nitrate, chloride, and fluoride) concentrations, and total organic carbon concentrations.

By far the largest potential health problem found was coliform contamination. Thirty-one percent of the wells were found to contain fecal coliforms. This percentage was the same for both lakeside and the rest of the watershed. It was similar for farms (30%) vs. residences (33%). However, the quarry well was uncontaminated. Contaminated wells were found on both small and medium residential lots (three on each). In Louisa as a whole, 25% of the wells tested positive for fecal coliforms. The percent of wells that were contaminated by fecal coliforms in the county as a whole was lower for small lot residential (18%) than for

medium-lot residential (29%) or for agriculture (33%). The relationship of contamination for small vs. medium-size residential lots is surprising. The likelihood of contamination would be expected to have an inverse relationship with lot size. However, it should be kept in mind that the study as a whole (and the Lake Anna portion of it in particular) tested a relatively small number of wells. The proportion of wells found to be contaminated in this study should not be taken to be absolutely representative of the percentage of wells contaminated in the entire area, but definitely indicates that a problem exists with fecal contamination of well water.

Total coliforms were found in an even greater percentage of wells than fecal coliforms: 41% in the Louisa portion of the Lake Anna watershed, and 60% in Louisa as a whole. However, total coliforms can come from sources other than fecal contamination, such as plant matter, and are therefore not as strong an indicator of the possible presence of pathogens.

Sixty-two percent of the wells in the Louisa portion of the Lake Anna watershed, and 75% of those in the entire county, had pH levels lower than 6.5. Low pH is not a health problem in and of itself, but acidic water can dissolve pipe material faster. This is of particular concern in older homes with lead-soldered pipes.

Of the remaining parameters tested, only manganese and nitrate were found at elevated levels in the Louisa portion of Lake Anna watershed wells. Manganese is not a health problem, but can cause stains and taste problems at levels above the secondary maximum contaminant level (SMCL) of 0.05 mg/L. Four wells in the Louisa portion of the watershed, or 14%, had manganese levels above the SMCL. This percentage was the same as in Louisa County as a whole. One well, or 3%, had nitrate levels exceeding the MCL of 10 mg/L. As discussed in the surface water section, high concentrations of nitrates can have serious health effects for infants and small children. Three percent was also the portion of all Louisa County wells tested that had high nitrate levels. All but one of the wells found to be contaminated with nitrates, including the well in the Lake Anna watershed, were on farms. Iron and sulfate were also found at high levels in wells in Louisa County, at 6% and 0.8% over SMCL respectively, but not in the Lake Anna watershed. Both iron and sulfate are nuisances, but not serious health threats. No lead, copper, zinc, chloride, or fluoride was found in any well above MCL or SMCL, and no wells had total organic carbon levels above the normal range.

Groundwater Quantity

Staff from the Department of Mines, Minerals, and Energy Division of Mineral Resources scanned paper records of water well completion records (GW2's) for all existing wells permitted by the Louisa County Health Department as part of the Louisa County Water Quality Management Plan and Groundwater Study, completed in January 1998. Records for 2155 drilled wells and 1743 bored wells were input

into a database; 1881 drilled wells were able to be located as to tax map and were analyzed with respect to initial well yield and casing length (a measure of depth to bedrock). The average yield per well for the entire county was 14.7 gallons per minute (gpm), which appeared to vary according to rock family (as well as could be determined given the lack of exactitude in locating the wells). The Lake Anna watershed (approximated by those tax maps which are at least 50% in the watershed) as a whole has a just slightly higher yield per well of about 15.1 gpm. However, 61% of the 82 drilled wells with reported yields of 50 gpm or more are immediately adjacent to Lake Anna. An additional statistical analysis determined that average well yields are indeed higher in areas adjacent to Lake Anna. This is likely due to the large hydraulic gradient created by the lake itself, which results in faster groundwater recharge. Casing lengths averaged 69.2 feet in the county as a whole and in the watershed. Casing lengths varied somewhat by rock family, but were within 20% of each other for all five rock families found in Louisa County.

There are two caveats on the water well completion record data. One is that the yields reported are initial yields, which are generally larger than the sustainable yield of a well. The other is that the Louisa County Health Department records contain very few reports of dry holes that were drilled and not completed. If all of the wells that were drilled without producing any water were included in the analysis, average yields would be lower.

Without additional analysis, the full extent of the quality and quantity of groundwater is unknown. Given the importance of groundwater in the watershed, serious consideration should be given to additional analysis. Orange County does have a proviso requiring well testing prior to development of large parcels which will preclude development without sufficient groundwater. Louisa and Spotsylvania should consider enacting similar ordinances.

Groundwater Contamination

As evidenced by the Louisa County Water Testing Program results for fecal coliform contamination of wells, groundwater contamination is definitely a risk for the Lake Anna watershed as well as many other areas. The DRASTIC methodology was developed by the EPA and the National Water Well Association as a way to identify areas most susceptible to groundwater pollution. A pollution potential index is developed, based on seven parameters that make up the DRASTIC acronym:

- Depth to water
- Recharge
- Aquifer media
- Soils
- Topography

- Impact of vadose zone (defined as the area between the soil and the water table)
- Hydraulic Conductivity.

So far in the Lake Anna watershed, only Louisa County has had a DRASTIC analysis performed (Thomas Jefferson Planning District Commission [TJPDC], 1991). Areas that were determined to be highly susceptible to groundwater contamination were proposed to be incorporated into Groundwater Protection Overlay Districts (GPOD), which would have requirements for septic system management, underground storage tank monitoring, solid and hazardous waste siting, well construction standards, water quality testing, and minimum lot sizes. The GPOD areas are scattered throughout Louisa County, including some in the Lake Anna watershed.

Threats

IMPERVIOUS SURFACE

The biggest threat to future water quality in Lake Anna is probably increased development. For example, according to maps by MSAG and RADCO, only 35% of parcels within the inner ring around Lake Anna currently have structures on them. This can certainly be expected to change in the coming years. Increased development brings many pressures: more septic systems, more fertilized yards, more boats, more pets, but above all, more impervious surface. The amount of impervious surface in a watershed provides a measure of surface runoff. For instance, an asphalt parking lot is an example of a 100% impervious surface; no rainwater can get through to the ground, it all runs off into the closest waterway. However, even areas without substantial pavement or buildings can be an impervious surface, in the sense that the ground can become compacted and not absorb as much water as it would otherwise. The table in the Appendices shows the values, based on research of the literature on the topic that the Rivanna Roundtable used to calculate impervious cover in the Rivanna watershed (Rivanna River Basin Project, *State of the Basin: 1998*).

Many studies have found a direct correlation between amount of impervious surface and water quality - the more impervious surface, the more pollution. Furthermore, there seem to be distinct thresholds. At about 10% impervious surface (a watershed full of one-acre lots), the water quality starts to drop, and the water body is no longer capable of supporting all of the forms of life that it had in the past. By the time the watershed is covered by 25% impervious surface, the quality of water in the water body is seriously degraded, and only a fraction of potential species are present. Impervious cover has numerous effects, including:

- runoff during storms increases, as does erosion and destruction of streambeds;
- runoff is of poorer quality due to deposition on surfaces such as roadways, driveways and parking lots;
- dry weather flow declines, because the soil was not able to absorb as much during rainfall and therefore does not contain as much water with which to recharge the stream during dry weather;
- water temperatures increase due to heat transfer and loss of tree cover (not as likely to be an issue for a lake as for streams and small rivers);
- aquatic community diversity is lost.

Preventing loss of water quality and degradation of habitat by limiting the impact of impervious surfaces and erosion is the purpose of the eight tools of watershed protection.

EROSION [TAKEN FROM LAAC REPORT]

Erosion may be broadly divided into two types: geologic and accelerated. Geologic erosion is caused by the forces of nature, such as glaciers, earthquakes, volcanic action, freezing and thawing, wind, water, etc. over time. Geologic erosion is the natural process that shapes the landscape and creates soils. Man can do little to control the forces of nature that cause this type of erosion.

Accelerated erosion is caused by human activity that disturbs vegetative cover on the landscape exposing it to the elements of nature. Activities such as farming (tilling the soil), producing livestock or poultry, harvesting timber, constructing buildings, roads, mining, or quarrying accelerate the natural or geologic erosion process. Accelerated erosion may be caused by the action of wind or water on the human disturbance of the landscape. In the Lake Anna watershed, water, in the form of precipitation, accounts for 99 percent of the accelerated erosion. With water erosion, it is the force and intensity at which the storm occurs that causes the erosion damage. For example, a thunderstorm that produces 1 inch of rainfall in 30 minutes produces far more energy to erode than the slow, steady storm that produces an inch of rainfall in 6 hours.

See the appendices for the method of calculating accelerated erosion rate and the watershed erosion rate estimate.

Reducing Erosion Rates

Accelerated erosion in agricultural situations can be reduced by:

- Using minimum tillage techniques when tilling cropland fields.
- Conducting all farming operations on sloping fields parallel to or at right angles to the slope.

- Alternating strips of close growing crops with row crops.
- For long gentle slopes or steep slopes longer than 75 feet, installing terraces or diversions to break slope length and safely remove excess runoff.
- Maintaining sod in natural depressions or waterways which collect and channel excess runoff.
- Reseeding sloping pasture or hayland fields in strips 60 to 100 feet wide depending upon the steepness of the slope.

Accelerated erosion on construction sites (residential, industrial or road construction) may be reduced by following state and local standards which are based on these principles:

- Reduce the area of exposed soils to the minimum possible.
- Reduce the time of exposure.
- Divert runoff water away from the exposed area.
- Reseed and mulch the area as soon as possible after completion of the earth disturbing activity. If weather conditions are not suitable for seeding use a dormant seeding or just mulch until the area can be reseeded or surfaced with erosion resistant covering.

Lake Shoreline Erosion

Of all erosion types, lake shoreline erosion is the most difficult to estimate without original cross section surveys of the lake at the time of construction and at the present. Shoreline erosion is primarily caused by wave action. Waves are caused by wind and wakes from boats and therefore is a combination of accelerated erosion caused by man and geologic erosion caused by nature. What can be considered slight winds over land become more significant over water where the surface is level and there are no obstructions to slow or divert the wind.

Waves lapping the shoreline undercut the soil at the waterline causing banks to collapse over time and slide into the water. Receding waves carry soil particles away from the shoreline with some staying in suspension while the heavier particles move outward into the lake as they settle out. Discussions with some long time lake front property owners have indicated that they have lost an estimated 5 to 20 feet of land at points on their property. What is not known is the exact amount of time required for these losses to occur. Estimated sediment production along a one-mile section of unprotected lake shoreline ranges from 20 to 150 tons per year depending upon shoreline bank height, vegetation, and exposure to wave action and soil texture. Generally, shoreline banks of 30 inches or less in height have the greatest exposure to erosion because that is the approximate maximum wave height under extreme conditions for Lake Anna. Undercutting of banks will cause some slumping which would increase sediment amounts while other banks with exposed bedrock would be non-erosive.

Streambed Erosion

The miles of streams within the Lake Anna watershed were tabulated by computer using the 1: 100,000 scale USGS topographic map with hydrology layers and by planimetering the 1:63360 scale satellite image map. The computer tabulation indicated 295 + miles and the planimetering indicated 320 miles. For purposes of this report the planimetered amount is used. See the following table. Neither tabulation included all intermittent streams that flow only during periods of high runoff.

Table 3. Miles of Streams (source: Lake Anna Advisory Committee report)

Hydrologic Unit	Louisa	Orange	Spotsylvania	Total
North Anna	94	36	0	130
Pamunkey	19	104	46	169
Contrary	21	0	0	21
Total	**134**	**140**	**46**	**320**

The computer tabulation also showed streambed acreage that totaled 13,329 acres. This acreage is not fully reflected in the land use acreage tabulation as water area because the land use data does not tabulate water areas of less than 40 acres in size. Since many of the watershed streams are narrow in width, it takes a mile or more to total 40 acres, therefore they were not included in the land use data as water areas, but rather in the adjoining land use tabulation.

Flowing water in streams produces energy that increases as volume and/or velocity increases. Thus flowing streams have the capability to move soil from both the banks and bed of the stream. According to NRCS, streams within this rainfall force and intensity region produce an average of 16.4 tons of sediment per mile. Control of this sediment source is extremely difficult in that control of one area simply changes velocity and flow characteristics in the uncontrolled area. The result is a transfer of energy to another portion of the stream.

Total erosion production from the 320 miles of stream produces 5,248 tons of sediment per year on the average.

Sediment Yield Summary

Sediment yield from all erosion sources discussed in this report is summarized in the following Table. Not all of the erosion that occurs on the land ends up as sediment in the water. Sediment delivery is a function of drainage area size and erosion-index units. According to figure 6-2 in the National SCS Engineering

Handbook, only about 23 percent of the soil erosion from land ends up as sediment in the lake. Erosion from the shoreline and streambeds ends up as 100 percent sediment. It should also be noted that computation of erosion or sediment tons uses reasonable averages because of the variable weight and dryness of different soil textures, the amount of organic matter present, and size of soil particles. The purpose of any erosion assessment is to give the reader a snapshot of a complex natural process usually accelerated by human activities.

Table 4. Estimated Annual Sediment Yield

Source	Yield Tons/year
Land Erosion (338,644 tons, 23%)	77,888
Shoreline (100%)	15,520
Stream Bed (100%)	5,248
Total	**98,656**

In the 25 years of the lake's existence this means some 2.4 million tons of sediment have entered the lake. The original volume of Lake Anna when constructed was approximately 325,000-acre feet. Assuming that it takes an average of 1,800 tons of sediment to replace one-acre foot of water, the lake has lost 1,370-acre feet of water by sedimentation exclusive of the additional unknown loss of volume of water created by shoreline erosion over the same time period. This amounts to slightly more than a 4 % loss of water volume over 25 years. This is known as the lake aging process (eutrophication) which over time could pose a serious threat to the utilization of the lake. The resultant problems - prolific weed growth, algal blooms, impaired water quality, deteriorating fisheries, and sediment infilling - would significantly reduce economic and aesthetic values around the lake.

Reduction of accelerated land erosion (potential for reduction, see Appendices), is 212,863 tons of soil loss which equals 48,958 tons of sediment) and protecting waterfront properties with stone or wood backed with erosion fabric could reduce shoreline erosion by 40 to 50% (6,000 to 7,500 tons). This would reduce the present overall sedimentation rate by 50% and slow the accelerated lake aging process.

The role of sediment as a carrier of other pollutants has already been mentioned in this report. According to USDA Misc. Pub. Number 1065, a ton of sediment from agricultural or forested land contains 2 pounds of nitrogen, 1.3 pounds of phosphorous and 2 pounds of organic matter. On this basis the 98,656 tons of sediment entering the lake each year would carry 99 tons of nitrogen and organic matter and 64 tons of phosphorus exclusive of any animal wastes, pesticides or other organisms that may also be in the sediment. Generally nutrient content of sediment

is higher during heavy runoff events in the spring. Pesticide movement in sediment is more variable due to rate and extent of use and will require monitoring on-site to determine amounts.

Gas and Volatile Hydrocarbons

Conventional two-stroke engines, used by personal watercraft (PWC) and some outboard motor boats, inject harmful carcinogenic hydrocarbons into the water and air. According to the EPA a 70 hp two-stroke engine (this is much larger than a PWC engine) operating for an hour releases as much hydrocarbon pollution as a car driven 5000 miles. Also, about 1/4 of the engine's fuel is discharged, unburned, into the water. Although much of this evaporates, it is still estimated that about 10% remains in the water.

A possible contaminant that has been banned in some areas is the gasoline additive methyl tertiary butyl ether (MTBE). MTBE has been required to be added to gasoline in many air-quality non-attainment areas to improve combustion and reduce carbon monoxide emissions. The health effects of MTBE in humans are unclear, but animal studies have found that short-term exposure to large amounts can cause adverse effects on the nervous system ranging from hyperactivity and uncoordination to convulsions and unconsciousness. Long-term exposure to smaller amounts in animals has caused kidney damage and adverse effects on fetal development. There is also some indication of cancer development in animals. Given the uncertain nature of knowledge about this contaminant and the increased use of watercraft of this type, efforts should be made to keep informed about on-going research into the effects on humans of this contaminant.

Current Ordinances

As part of this study, the current ordinances in each county were reviewed by the respective planning departments for correlation with the standards for watershed protection developed by the Center for Watershed Protection. Each planner answered the same questionnaire, originally published in the Center for Watershed Protection's *Better Site Design: A Handbook for Changing Development Rules in Your Community* (1998), which included a scoring system with points assigned for each question (the higher the point score, the better). The table in the appendices summarizes the questions and lists the answers and points for each locality. As can be seen from the table, there is room to improve local ordinances in all localities for better protection of the water resources. Spotsylvania County had a greater compatibility with the standards due, in part, to the fact it is a Chesapeake Bay community and has been required to include certain activities in its local ordinances and regulatory actions.

Implementing the recommendations of the Lake Anna Special Area Plan would be an important step in improving the scores of all the localities and result in a higher quality of water due to protective measures.

VI. Findings and Recommendations

Summary of Findings and Recommendations

GENERAL FINDINGS

People living in and around the Lake appreciate the quality of life that exists in the Lake Anna watershed and want to protect and preserve that quality into the future.

The population of the Lake area has grown in the last ten years. The exact percentage is not available because the most recent Census data date back to 1990 and the block boundaries have changed each decade, making comparisons unreliable. The population is also seasonal due to the number of vacation or second homes.

Data available for this study were spotty at best. Monitoring of pollutants and nutrients is not consistently reported in a manner that allows full analysis of the conditions, particularly those in the Lake. It is expected that the York Watershed Tributary Strategy will address some of the data needed and expand on recommendations made in this Plan.

Development has taken place primarily in the Inner Ring of Louisa and Spotsylvania Counties. Orange County has no land in the Inner Ring.

GENERAL RECOMMENDATIONS

The primary recommendation in this report is the creation of an Overlay District. An Overlay District provides the framework within which land use planning, growth management, watershed protection, and all other programs can be organized. This approach is recommended to maximize the efficiency of the programs and to ensure a consistent approach is taken to implement strategies related to the health, safety, and welfare of Lake Anna, its residents, and its watershed.

> *Definition of an "Overlay District": An overlay district is a delineation of an area on the map of a local plan and/or ordinance within which special requirements are set forth. In the proposed Lake Anna Overlay District, certain water quality protection measures are suggested for implementation and incorporation into local plans and ordinances.*

Unless otherwise noted, the specific recommendations in this report are to be implemented in the Lake Anna Overlay District. Where plats have been recorded or uses zoned, they will be "grandfathered" or allowed to remain as uses. New

development would be subject to the recommendations implemented by the three local governing bodies.

I. Create a Lake Anna Watershed Overlay District in all three counties where the localities agree to a consistent approach to land use management, watershed management programs, transportation, and public services. The Overlay District will contain two tiers or regions:

   A. Tiers

      1. Inner Ring: those properties which abut the lake and that area of development immediately adjacent with water access.

      2. Watershed: Comprised of the land area within the Watershed Boundary, including the Inner Ring.

   B. Develop, implement, and enforce uniform zoning, site plan, subdivision, and watershed management programs in all three counties, using consistent standards to ensure water quality.

   C. Evaluate all land use activities in the Overlay District primarily in terms of the effect on water quantity and quality.

   D. Maintain densities at a level that can be served by well and septic systems or require wastewater treatment systems to tie into a municipal system.

II. Require the Lake Anna Advisory Committee to track progress toward meeting the goals of this plan and submit annual progress reports.

   A. The local governing bodies are the final responsible parties. However, the Lake Anna Advisory Committee's role concerning this plan should be clearly defined within the local planning process. The Lake Anna Advisory Committee was created using state law for inter-jurisdictional planning activities and therefore can take on a legal role as defined by the three localities.

   B. Identify an organization(s) which would focus on preserving land for agriculture or open space, especially in the Inner Ring using any one or more of the following tools:

      1. Purchase property or development rights.
      2. Hold easements, both short term and perpetual.
      3. Conduct education programs, including:
         a) Septic system management
         b) Proper use of lawn care products
         c) Best Management Practices (BMPs) in conjunction with the Soil and Water Conservation Districts.

III. Create a sufficient data base and monitoring program for decision-making. This activity will require local, federal, state, and private sector funding which will be sought by the localities, acting together.

A. Identify industrial, private, and municipal point source sites and work with state agencies to improve point source discharge monitoring for all point sources.

B. Institute on-going monitoring of the tributaries to detect nutrients and pollutants, with emphasis on impaired streams.

C. Determine sources of fecal contamination and implement appropriate reduction strategies that respect the value of agricultural uses currently in place.

D. Institute a water quality monitoring program in the Lake itself to determine presence of heavy metals, nutrients, and pollutants.

E. Measure impacts (hydrocarbons, oil, gas, etc.) from boats and personal watercraft as they apply to water quality.

F. Establish hydrogeologic database, including information on water wells and failed septic systems.

G. Conduct geologic study of areas adjacent to Lake, particularly where subdivided.

H. Implement recommendations of the York River Tributary Strategy within Watershed.

IV. Seek funding for watershed programs.

LAND USE AND GROWTH MANAGEMENT FINDINGS

Watershed land use is primarily forest and agriculture.

Inner Ring land uses are primarily residential, with about one half of the land zoned for residential use having been developed. Some residential areas are zoned for higher densities and have not yet been developed.

Land use standards in the comprehensive plans and the zoning, subdivision, and site plan ordinances are different in each of the three counties. The three local plans do not use the same standards for development. The three counties do encourage clustering, but none specifically use the standards promoted by the National Farmland Trust Conservation Planning which maximize land conservation and retain the unique features of a site.

Residential uses are the primary uses in the Louisa and Spotsylvania comprehensive plans, agriculture dominates the Orange plan, and some commercial and business is shown along Route 208 and in Bumpass.

Land cover, per satellite imaging, appears to be primarily forests; however, there are subdivisions with heavy tree canopies that may be misread by aerial photographic techniques. This is evident in the Inner Ring when subdivisions are overlaid on the satellite maps. (Map #4: Lake Anna Watershed Land Cover) Experts consider forest land to be the best buffer for protecting the water quality and providing habitat for wildlife in and near the Lake and streams.

Twenty-five abandoned mines are located in the Watershed. Many of these mines have unsealed shafts and are subject to subsidence.

Land presenting constraints for development occupies about one third of the land area and is scattered throughout the Watershed, not following a definite ridgeline. (Map #5: Lake Anna Watershed Soil Constraints for Septic Field Operation and Map #6: Lake Anna Watershed Steep Slopes). Development constraints include steep slopes, soils with severe limitations for septic systems and land adjacent to water bodies. Approximately 3% of the Watershed area have soils suitable for septic fields; 82% have soils with moderate limitations and 15% have severely limited soils. Properly designed and maintained septic systems may be used in areas with moderate limitations.

LAND USE AND GROWTH MANAGEMENT RECOMMENDATIONS

I. Use a uniform approach to manage growth in the watershed to maintain water quality, environmental quality, the quality of life and the rural character of the environs, while maintaining public safety.

   A. Continue existing and create new Agricultural/Forestal districts which preserve and maintain buffers

   B. Support land use taxation to preserve rural character

II. Identify village centers and concentrate public service activities and commercial development in those centers.

   A. Locate public water and sewer services in Village Centers or Town Centers

   B. Encourage future commercial development in Village Centers or Town Centers

   C. Encourage “dark sky” lighting, parking in the rear of buildings, sign ordinances, and village streetscapes.

III. Implement zoning and subdivision ordinances with the following standards:

A. Inner Ring:

1. Incorporate design standards and cluster subdivision provisions for future Inner Ring subdivision development which will result in open space, with a goal of reaching 50% open space. Open space can include common septic fields, wetlands, flood plains, steep slopes, common areas, groundwater recharge areas, and other environmentally sensitive areas. To the extent a landowner chooses to reconfigure existing platted, but as yet undeveloped, subdivisions to meet this goal, incentives (such as increased density) will be developed and put in place.

2. To minimize the adverse effects of human activities on water quality, wildlife habitat, and environmentally sensitive areas, a minimum 100 foot buffer including, but not limited to, the Virginia Power easement area from the normal water line of the lake should be required. The buffer may be included in the open space calculation. In lieu of the full 100 feet of buffer, a combination of natural vegetative buffer and Best Management Practices may be used provided the combination will achieve the same estimated nutrient and pollution removal efficiency as modeled in the state-wide tributary strategies process. Exceptions to the 100 foot buffer require special permitting and site review process.

B. Watershed (including Inner Ring)

1. Post-development runoff water quality should be equal to or better than pre-development water quality.

2. Plans for future residential, commercial, or mixed use developments should adhere to the standards developed by the Center for Watershed Protection. These standards have been developed to minimize impervious surfaces which contribute to non-point source pollution. The standards include:

   a) Reduce negative impacts of roads by minimizing street and road rights-of-way width without sacrificing safety, minimizing street length, the size and number of cul-de-sacs, relaxing setbacks and frontages along subdivision streets to encourage clustering and environmentally-friendly site planning.

   b) Improve the quality of stormwater runoff by using vegetated open channels to convey stormwater runoff, providing stormwater treatment for parking lot runoff, creating naturally vegetated buffers along streams and

adjacent to the Lake, preserving stream buffers throughout the development process, limiting clearing and grading of forests and native vegetation during the development of the tracts, conserving native trees and plants; planting additional trees and native plants, and not allowing discharge of unmanaged stormwater into water bodies.

c) Reduce imperviousness associated with development by reducing required parking ratios (parking spaces/square foot), lowering parking requirements where alternate transportation is available and providing incentives for structured and shared parking, promoting alternative driveway surfaces and shared driveways, and directing rooftop runoff to pervious areas.

d) Manage community open space to minimize non-point source pollution.

e) Develop incentives to preserve areas of environmental value, and encourage off-site mitigation.

IV. Louisa and Orange Counties should work with the towns within their respective boundaries to insure that ordinances are watershed friendly and compatible with the county-wide ordinances.

WATER QUALITY FINDINGS:

Implementation of Best Management Practices is different in each of the three counties. Enforcement of existing soil and erosion control ordinances is limited by the availability of staff.

DRASTIC mapping is a methodology used to "flag" areas for a higher level of scrutiny should development be planned. It identifies groundwater pollution potential of lands based on seven parameters. This has been completed only in Louisa, where a significant proportion of the land shows high susceptibility to groundwater pollution. These areas should require additional testing for certain land uses.

Water quality data are extremely limited. No substantial pollutant or nutrient data are currently being collected on the Lake itself. Groundwater and its relationship to the Lake has never been studied.

Five tributaries to the Lake are on the state "impaired" list. (Map #9: Lake Anna Watershed 1998 Impaired Streams and DEQ Monitoring Stations) The major pollutant is fecal coliform. This could come from any of a number of sources including poorly functioning septic systems, wildlife, livestock, or pets. Additional

study would be necessary to type the coliform source. The York Watershed Council is doing stream walks, creating georeferenced digital photographs and detailed information sheets, to try to determine the causes. One of these streams, Plentiful Creek, enters the Lake 1.2 miles upstream from the public beach.

High levels of phosphorus were found in Goldmine Creek by DEQ several times in 1993-1995.

Contrary Creek, while not currently on the impaired list, has a pH between 3-4 due to acid mine drainage from abandoned mines along the creek. (It will be included on future impaired listings).

No database exists on failing wells or septic systems or the types of wells. Some of this data exists with the Health Department, but has never been compiled and systematically analyzed, with the exception of some preliminary work done in Louisa County. The Health Department's records of failing wells and septic systems are very spotty at best. Most of them go unreported.

Based on information from the Division of Soil and Water Conservation, 50% of crop and grassland, 20% of forested land, and 12% of all other lands are subject to excessive erosion.

Shoreline erosion rates range from 20 to 150 tons per year, with the higher rate applying to shoreline banks of 30 inches or less due to the wave heights experienced on the shoreline.

Homes and businesses in the Watershed generally use groundwater for drinking water and septic tanks for wastewater disposal. A systematic study of the soil and geologic conditions in the entire watershed was not possible for this plan due to costs of such a study. However, data exist for Louisa which indicate potential for future problems both of quality and quantity of groundwater. In general, experts in the field do not feel septic systems are good long term solutions for waste water treatment.

WATER QUALITY RECOMMENDATIONS.

I. Promote use of existing programs to protect streams and Lake, such as the Soil and Water Conservation District technical assistance and BMP program, tax incentives under state law, etc.

   A. Create a useable database of problem areas

   B. Identify financial and technical resources to assist with implementation:

      1. Tax incentives.

2. Work with technical assistance from the Soil and Water Conservation Districts to implement cost-sharing Best Management Practices to control non-point source pollution. Possibilities include, but are not limited to, fencing, alternative water sources, buffers, erosion control, animal waste management, nutrient control.

3. Prepare grants and seek funding on a watershed basis for water protection. Sources include the Water Quality Improvement Fund, EPA 604(b). Studies should include development of the data base, hydrogeologic study of the watershed, and remediation of acid mine drainage.

II. Protect shoreline stability

A. Require pre- and post-development review of erosion and soil reduction installations along the lakeshore to insure proper installation is carried out as part of the erosion and sediment control program in each county.

B. Require submittal and approval of a shoreline stabilization plan for all developments with greater than three hundred feet of shoreline and a review of smaller or existing installations to insure their effectiveness in maintaining the shoreline.

III. Improve and preserve surface water quality for swimming, fishing, boating, and other recreational activities while providing adequate habitat for and maintaining maximum diversity of fish, plants, and wildlife.

A. Set standards for impervious surface or implement protective measures such as buffer strips to mitigate impact of runoff and nonpoint source pollution.

B. Enforce and monitor a uniform ordinance regulating chemical weed control applications by licensed persons.

C. Prohibit untreated industrial discharge in the watershed.

D. Establish a goal of 15% or less of impervious cover in the watershed.

IV. Protect groundwater supplies in Lake Anna watershed.

A. Institute a program by which the conditions of groundwater can be ascertained to protect the quality and quantity of the resource.

B. Map failed septic areas. Test wells in failed septic areas.

C. Perform DRASTIC studies for Orange and Spotsylvania Counties and use to establish groundwater protection zones.

D. Establish wellhead protection areas for public wells.

E. Locate underground storage tanks. Monitor nearby wells.

F. Relate development to soil suitability.

V. Improve septic system management.

A. Enforce existing regulations.

B. Encourage use of alternating functional drainage fields.

C. Require setback of septic fields from streams and Lake sufficient to protect water quality.

VI. Require environmental audits for large scale development in the watershed.

VII. Institute a comprehensive education program to insure users of the Lake are part of the program to protect the water quality of the Lake and its tributaries.

A. Designate or create a group to be responsible for a citizen monitoring and education campaign.

B. Offer instruction on how to implement Best Management Practices.

C. Educate campers regarding proper camping practices.

D. Continue "Land on Lake Days."

E. Encourage water conservation.

F. Make boaters aware of pumpout facilities and educate concerning proper disposal of porta potties.

G. Reduce littering on land and water.

VIII. Develop and implement a uniform stormwater management program which includes VDOT construction and facilities.

IX. Use special district designations to prevent development in former mining areas until such areas have been remediated.

TRANSPORTATION FINDINGS:

Users of the roads encircling the Lake experience unsafe conditions, especially when encountering wide loads, such as lumber trucks and large towed boats. The circumferential roadway proposed in the original Virginia Power plan has not materialized. Cars or trucks towing boats to the Lake from all directions present a safety hazard, particularly as roads have been widened and shoulders narrowed, sometimes leaving no shoulder for safety. No bikeway exists in this recreation-oriented area.

Existing roads may be required for evacuation routes and the limited road capacity may not be sufficient for safe, efficient evacuation of people within the watershed at any given time.

TRANSPORTATION RECOMMENDATIONS:

I. Upgrade existing roadways to create a circular transportation route around Lake Anna to provide adequate lanes for towed boats and bicycles. Ensure roads provide safe evacuation routes.

   A. Improve Route 601, 612, 652, 701, 208N, 522N, 719E, and 618 to function as a circumferential travelway for vehicles, bicycles, and pedestrians

   B. Insure that Virginia Power evacuation routes will provide easy access to evacuation sites.

   C. Include bicycle trails and lanes in transportation plans and all road improvements

   D. Preserve Routes 522, 738, and 208 as efficient, safe access roads to the Lake by limiting development along these roadways

   E. Consolidate access points to create limited access on state secondary roads to enhance safe travel

   F. Expand demand/response and fixed route rural transportation services

   G. Create a system of Park and Ride lots

UTILITIES FINDINGS:

Telephone and electric utilities have been placed underground in many of the developments. This contributes to the general quality of the vistas in and around the Lake. Virginia Power has fiber optic cable in the watershed.Several natural gas and petroleum transmission lines cross the Lake, but do not serve the area. Leaks have occurred in the recent past, on the fringe of the Watershed.

Long distance calling areas and postal services are not Lake-oriented and cause confusion and additional costs for Lake area residents.

Problems posed by private wastewater treatment facilities include lack of monitoring, quality of operations and maintenance, and lack of enforcement of permit regulations.

UTILITIES RECOMMENDATIONS:

I. Maintain densities at a level that can be served by well and septic systems or require wastewater treatment systems to tie into a municipal system.

   A. Site and restrict public water and sewer to service districts in towns and villages

B. Prevent proliferation of private waste water treatment plants

C. Require well casings to bedrock

II. Petition phone companies to eliminate long-distance charges within the Inner Ring and the Postal Service to allow residents to opt to use "prestige address" of "Lake Anna, Virginia," while continuing to use their existing zip codes.

III. Enforce State Health Department boat waste disposal regulations which require sanitary facilities in future common areas and use of disposal facilities by day boaters.

PUBLIC SERVICES FINDINGS:

Fire and safety concerns center on the difficult access to many developments due to private road systems, which are not up to state standards.

Dry fire hydrants are not provided in all residential areas

Solid waste collection is not uniform in watershed

PUBLIC SERVICES RECOMMENDATIONS:

I. Develop watershed-wide emergency plans for gas and petroleum transmission lines and/or upstream dam breaks. An emergency services plan is in place for the Virginia Power nuclear facility. This should be reviewed on a regular basis.

II. The level of public services should be consistent with the rural nature of the Watershed area, with higher levels of service in Village Centers and Town Centers.

A. Review response times for fire and rescue services, creating additional services as necessary for the safety of residents and users of the Lake.

B. Require dry hydrants in Inner Ring developments.

C. Locate solid waste collection sites in all three localities.

D. Provide sufficient resources to insure safety on the Lake.

E. Provide pads for emergency helicopter rescue service.

RECREATION FINDINGS:

The original plan called for a public park in each County. Public recreation access is limited to the eight private marinas and four private campgrounds which charge fees,

one fee-based State Park, the free fishing launch area on Route 522, and the free fishing area at Dike 3.

Plans to expand State Park facilities met with public resistance. The current state park has eight miles of lake frontage, a small portion of the total lake shore mileage of 200 miles.

The latest available data show that 186,000 visitors came to the Lake Anna State Park in 1998 to swim, picnic, hike the nature trail, and launch their boats.

RECREATION RECOMMENDATIONS:

I. Counties should continue to work in partnership with the Department of Conservation and Recreation to develop acceptable plans for expanding the Lake Anna State Park. Improvements should be planned with adequate citizen participation in the decision-making process.

II. The counties, either individually or in partnership, should identify areas for future parks and recreation and acquire additional park land for public access to Lake Anna as funding becomes available.Development of such parks should be environmentally sound, using natural buffers and minimal impervious surfaces.

ECONOMIC FINDINGS:

The Lake is an economic asset to the Counties of Louisa, Orange, and Spotsylvania and the Commonwealth as a whole. The major industry in the Watershed is the North Anna Power Plant, a nuclear energy plant owned by Virginia Power (formerly VEPCO), located on the southern shore of the Lake. Virginia Power paid $11.4 million to Louisa County in the last fiscal year.

According to the agriculture census, agriculture is an important land use environmentally and a valued contributor to the economy of the Lake region. The value of agricultural land and buildings per acre has increased 33% in Louisa, 39% in Orange, and 55% in Spotsylvania from 1982-1992. These increases reflect the pressure of development as well as the value of agriculture. The value of agricultural products sold has increased in Louisa and Orange, but has decreased in Spotsylvania. Over this ten year period, the number of farms in all counties has decreased, while the size of the average farm has increased in Louisa and Spotsylvania and remained stable in Orange. The farming community has recognized the importance of land stewardship through implementing Best Management Practices (BMPs) with assistance from the Soil and Water Conservation Districts under a cost-sharing plan. The demand for BMPs exceeds the funds available for this program.

Some commercial development has taken place along Route 208. Currently this consists of small grocery stores or mini-marts, gift shops, motels, and boating-related equipment shops.

ECONOMIC RECOMMENDATIONS:

Recognizing that investing dollars in the Lake Anna area benefits the entire tri-county area and the state, the Boards of Supervisors of the three counties should commit the resources needed to implement the recommendations set forth in this plan.

Land Use

The manner in which land is used and developed affects water quality, water quantity, air quality, and the general quality of life often termed as rural character. The Vision Statement seeks to preserve and protect the rural character of the Lake Anna Watershed. This is consistent with the visions articulated in the local plans. Land use is guided by the Plan and regulated through a series of ordinances such as the zoning ordinance, subdivision ordinance, and the site plan review. Regulations such as erosion and sediment control also contribute to the sensitive development of land. The Plan envisions enacting standards by which rural character and open space will be retained and still provide for development of land within the watershed.

The Future Land Use Plan for the Watershed is depicted on Map #10: Lake Anna Watershed Future Land Use Plan. The goal of the future land use plan is to maintain the water quality and character of the watershed and direct anticipated growth to growth centers to meet that goal. Grouping similar land uses together and creating a range for allowable densities achieves consistency between the three counties and with current Comprehensive Plans. Higher density development is generally restricted to existing towns and villages. Clustering of development is preferred in order to achieve open space and buffering goals and to minimize the impervious surface cover. It is recognized that many of the allowable lots have been platted and recorded. The committee recommends that these be “grandfathered” or allowed to be used as recorded. If there is a change in site plan, the opportunity should be used to develop these lots in a manner consistent with the standards contained in the Plan. Localities should be prepared to provide incentives to allow or encourage these changes.

A circumferential roadway and bicycle path is planned along existing routes, which are recommended for improvements. As planned improvements are implemented, it is envisioned bicycle paths will be incorporated into VDOT design and construction activities.

Consistent with the vision statement, stream and lakeside buffering are to be encouraged for existing development, required for new development. Use of the design standards at the end of this chapter will implement the concepts of this plan.

GROWTH CENTERS

Based on historic data, trends, and projections, there is a consensus that the three counties adjacent to the Lake will grow. What is important for the future water quality of the rivers, streams, and the Lake and the economy of the region is just how that is accomplished. To quote the Orange County Comprehensive Plan, "It will take good planning and consistent decision-making to encourage new development while preserving the essential quality that makes the watershed [county] such a good place to live." Spotsylvania envisions "Growth in the rural areas takes place in compact nodes. Old and new rural villages and hamlets have been developed preserving thousands of acres of farm and forestland in between." Drafts of the Louisa Plan link creation of growth centers with the ability to preserve agricultural and forestal assets of the county. All three localities commit to water quality protection, with special emphasis on Lake Anna. There is indeed a consensus throughout the watershed concerning how to grow: concentrate business/commercial/residential growth in town centers or village centers where services are more efficiently provided and preserve town/village character; protect the agricultural, forestal, scenic, and natural tourist destinations from the inefficiencies of sprawl and protect the water quality for drinking and recreational use.

Approaches to standards and on-the-ground applications do vary from locality to locality. Through this plan, localities are urged to bring more consistency to their approaches, but above all, are urged to protect the water quality in the rivers and streams that lead into Lake and protect the Lake itself. To do this will require leadership, informed decision-making and continuing citizen participation.

Towns

The towns of Orange and Gordonsville in Orange County and Louisa and Mineral in Louisa County are located on the outer edges of the watershed boundary. Towns, as incorporated municipalities, are independent governmental units, governed by a local Council and Planning Commission unless they have opted to remain under County governance. Towns are the most urban of the settings within the watershed and have distinct boundaries.

Concerns related to towns are those associated with sprawl and maintaining a healthy core of the town. Development on the edges can take on the characteristics of sprawl - strip commercial development with multiple curb cuts on main roads, small lot subdivisions with individual wells and septic systems and significant amounts of impervious surface. Sprawl draws business from the core of a town and leaves a need

to reclaim once-vital town centers. Sprawl is an inefficient land use pattern which most often ultimately requires public financing of expensive infrastructure. Sprawl also diminishes the attractiveness of towns and rural areas alike, moving the desire to develop further out from the core and using agricultural or forestal land. Given that the economies of Louisa and Orange have industries as a major component, and Spotsylvania's goal is to retain the rural character of this area of the County, it is important to address the development of towns. Actual town plans remain the purview of the town governments, but efforts to coordinate the town/county planning process are essential to the continued healthy growth of both entities.

This Plan envisions towns as the location of more intense uses such as industry, commercial and retail businesses, and higher density housing development. Public infrastructure will be provided within the boundaries through local government, regional authorities, or public/private partnerships. The provision of water and wastewater services will be limited to the boundaries of the town, village center or such boundaries that are mutually developed by the town and county. Towns have their own unique scale and will work to maintain this sense of scale to retain their attractiveness and economic viability.

SPRAWL-LIMITING STRATEGIES

Provision of infrastructure and utilities.

Where growth is desired by the community, public utilities should be provided to encourage the increased density of development both residential and business. Each county has this intent and direction within its current plan. This strategy is used in Spotsylvania County by establishing a "Primary Development Boundary," which "defines the area within which public facilities (water, sewer, etc.) will be provided. Services will not be provided by the County outside of the Primary Development Boundary, where development is discouraged. By establishing a Primary Development Boundary, the County will encourage more efficient use of the land while preserving the rural character of those portions of the County outside the boundary. . . This boundary is not permanent, and can be adjusted when conditions warrant."

Discourage strip development.

The Orange County Plan contains the following language that provides guidance: "The time to prevent strip commercialization is before it occurs. Turning traffic renders the highway slow and dangerous for through traffic. Individual entrances cost each business more than coordinated entrances would, and do not work as well. Each proposal for a new business in a rural area should be examined not as a stand-alone case in a vacuum, but with one eye on the cumulative impact of several such cases over the years. Otherwise, the county will one day look back over ten or twenty bad

decisions, each one harmless in itself, which combine to destroy the stretch of highway." Strip development can be discouraged by requiring combined access points, site designs which vary the street setbacks to provide parking in the rear of the enterprise, and landscaping requirements in site plan ordinances. Non-point source pollution can be addressed through retention ponds which also remove pollutants, use of pervious surfaces for parking, and placing a maximum on the parking provisions.

Village Centers

Villages are defined as unincorporated growth centers within which land is more intensively developed for business, commercial, and residential uses. Public utilities could be provided within the boundaries of a Village, should the density of development be planned for and require infrastructure support. Villages will provide a sense of community through continuation of a village scale in development, bike and pedestrian connections, site planning which requires landscaping, setting maximums on the number of parking spaces allowed, and use of pervious surfaces wherever possible in the development of the land. Where use of impervious surfaces is necessary, non-point source pollution from runoff will be diminished by use of retention ponds, small constructed wetlands, and landscaping. It is important to understand the need for environmentally sensitive development standards for all development to protect the water quality in the rivers and streams that flow into the Lake and the Lake itself. Village scale development offers opportunities for partnerships in water quality protection and, in certain cases such as along impaired streams, the opportunity to improve the water quality.

Neighborhood Commercial

Neighborhood commercial areas are located at the crossroads of Routes 208 and 601 and 601 and 612 in Spotsylvania County. In Louisa County, the neighborhood commercial areas are at the intersection of Routes 662 and 208 and Routes 208 and 522. Development in these areas will be of a higher density and will include commercial, retail, and services on a scale consistent with neighborhood development. The developments will be linked with bike and pedestrian facilities to minimize the need for single occupant vehicles and will be planned in such a way that they create a neighborhood atmosphere, not that of a strip development. Road access will be coordinated, varying setbacks used, and careful site planning instituted to provide protection to the watershed and a safe, harmonious place for residents. No industry will be encouraged in the Neighborhood Commercial areas.

DEVELOPMENT STANDARDS

Introduction

The way land is developed can have significant effect on the amount of non-point source pollution, the conservation of land features, the preservation of the environment and preservation of the rural character of a region. While the true heart of rural character is agriculture, forestry, and open space, the visual effects of how land is developed can also mean the difference between sprawl and the preservation of rural characters. The Center for Watershed Protection is one source for standards. The National Rural Land Trust is another. Many of the standards incorporated into the recommendations for this Plan have their origin in one or the other of these programs as well as in the BMPs set forth by state agencies.

The goals in using standards such as those proposed here are to:

- Protect the water quality of the rivers, streams, and Lake Anna;
- Diminish non-point source pollution from runoff;
- Maintain rural character.

Standards will vary as to their appropriateness from site to site. Growth centers will include a more urban approach; proximity to water will influence the standards to choose. What is included in this document are recommendations for standards to be used in the different land use categories, both within and outside of growth centers.

Watershed Protection

The eight tools of watershed protection are an organizing principle, developed by the Center for Watershed Protection, for methods of maintaining water quality on a watershed scale. These tools are presented in the appendices.

WATERSHED PROTECTION: BASIC APPROACH

Watershed protection standards are used to improve or maintain water quality in rivers, streams and lakes. Given the conditions in several streams flowing into Lake Anna and the unknowns about the lake itself, standards of development designed to protect water quality are proposed to be implemented in the watershed. To varying degrees the three localities use some of these techniques. The goal is to have a consistent approach throughout the watershed. Buffers and retention of runoff flow are such tools. Retention not only holds the runoff for flood prevention purposes, but does so in a way that nutrients are either filtered out or remain behind in the sediment. Buffers and holding ponds are the key elements to this strategy, combined with approaches such as grass swales instead of curb and gutter, grassy areas or

constructed wetlands in parking lots, rain gardens and barrels, and use of pervious materials for paving parking lots.

SCALE: FITTING COMMUNITIES TOGETHER

The height and bulk of a building can communicate a sense of community or insensitivity to surroundings. Scale is difficult to define, but can mean a gradual increase in height along a street, varying architectural details on similarly sized buildings, or the "new town" approach. The drawing that follows (Figure 1) is meant to convey one aspect of the concept of scale.

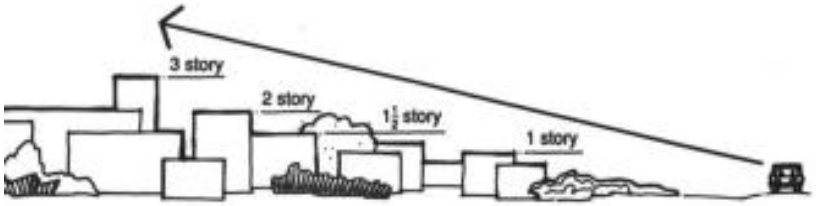


Figure 1: Appropriate Scale as Viewed from the Street

WATER-FRIENDLY ORDINANCES

In the analysis of local ordinances included in the appendices, the sensitivity to water quality protection was shown to be inconsistent and having room for improvement. The local ordinances should undergo a serious review in terms of protecting or improving the water quality in the rivers and streams of the watershed to provide protection to the water quality in Lake Anna. Model ordinances are available through the Center for Watershed Protection and should be used to guide the local discussions and development of the ordinances. Design standards follow in the Recommended Standards section.

VOLUNTARY STRATEGIES

Not all watershed protection strategies are regulatory. Some of the most effective strategies are voluntary and there are agencies with the responsibility of assisting individuals in carrying out these voluntary strategies. Some of the strategies have significant tax benefits to the landowner.

AGRICULTURAL/FORESTAL DISTRICTS

Agricultural/Forestal districts (*Section 15.2-4301-4314, Code of Virginia, 1950 as amended)* are a voluntary method that provides landowners with certain tax benefits, restricts public utilities in districts, and protects the agricultural/forestal use of the land through government action. In exchange, the landowner voluntarily agrees to

conditions that limit development of the property during the time the district is in effect.

CONSERVATION EASEMENTS

Conservation or open space easements *(Section 10.1-1700-1704, Code of Virginia, 1950 as amended*) for the purpose of protecting open space, are given by the landowner to the Virginia Outdoors Foundation or other public holding agencies such as a county government. Easements are individually negotiated agreements to limit development, but some ability to subdivide may be retained. The owner can continue with the traditional use, or new uses not prohibited by the easement. The minimum term of the easement is five years, but in order to qualify for federal tax deductions, the easement must be written for perpetuity.

BEST MANAGEMENT PRACTICES

Voluntary use of Best Management Practices (BMPs) is one of the best strategies to control runoff from agricultural and forestal activities. The Virginia Department of Forestry, Virginia Cooperative Extension Service and the Soil and Water Conservation Districts are available to assist the landowner in developing and implementing these practices. Cost sharing is available to implement the BMPs.

CONSERVATION PLANS

Conservation Plans are resource management plans for a landowner. The Soil and Water Conservation District is available to help with developing such plans. The plan addresses the soils, the landowner's land and goals, resource problems, and a conservation program. The plan helps the landowner take responsibility for present and future conditions of the soil, water, and other natural resources on the land. Changes in a plan can be made as needed, and implementation is voluntary.

Conservation Planning

Conservation Planning follows an approach which reverses many of the steps of conventional subdivision layout. It does not decrease the gross density, but results in clustering of activity and preservation of unique properties of the land to be developed. The process begins by identifying the environmentally unbuildable areas. These wetlands, floodplains, and steep slopes are blocked out from the planning area. In some cases, certain soils are removed as well. The second step is to identify the unique characteristics of the site. These could include forests, high quality agricultural soils, scenic vistas, or other historic or visually pleasing features. These areas are also blocked out as areas unsuitable for building in order to preserve the unique features. The next step in developing the site plan is to place the buildings on

the remaining land. The final step is connecting the buildings with roads and paths and drawing the lot lines. This approach has been shown to decrease the amount of impervious surface in a given development, maintain the initial gross densities, and save money by requiring less earthwork and pavement and clustering for more efficient service delivery. Conservation planning results in clustering of activity and preservation of unique properties of the land to be developed. A fuller description with examples of the process is included in the appendices.

Recommended Standards

Flexibility and incentives can be used to insure that development takes place in a manner that protects the water quality in the Lake Anna watershed. Incorporating these standards into local zoning/site plan ordinances will support the goal of improving and maintaining the water quality in the streams, rivers, and the Lake.

The following design standards are recommended for incorporation into local ordinances. The standards or principles presented have been developed by the Center for Watershed Protection and are reprinted here with their permission. The benefits to be derived from implementing these standards include:

- Protection of local streams, lakes, and estuaries
- Reduction of stormwater pollutant loads
- Reduced soil erosion during construction
- Reduced development construction costs
- Increase in local property values and tax revenues
- More pedestrian friendly neighborhoods
- More open space for recreation
- Protection of sensitive forests, wetlands, and habitats
- A more aesthetically pleasing and naturally attractive landscape
- Safer residential streets
- More sensible locations for stormwater facilities
- Easier compliance with wetland and other resource protection regulations
- Neighborhood designs that provide a sense of community
- Urban wildlife habitat through natural area preservation.

DESIGN STANDARD #1 STREET DESIGN: MINIMIZE PAVING REQUIREMENTS

Design residential streets for the minimum required pavement width needed to support travel lanes; on street parking; and emergency, maintenance, and service vehicle access. The width should be based on traffic volume.

Street width should be related to the type of traffic expected to be carried by the road and the safety access for emergencies. Often requirements overstate the necessary width. Tailoring road width to the actual demand will decrease impervious surfaces and, studies have shown, provide safer travel for users. Wider streets encourage faster speeds, which in turn can increase the rate of accidents. Development costs are lower with narrower roadways. Examples are shown below.

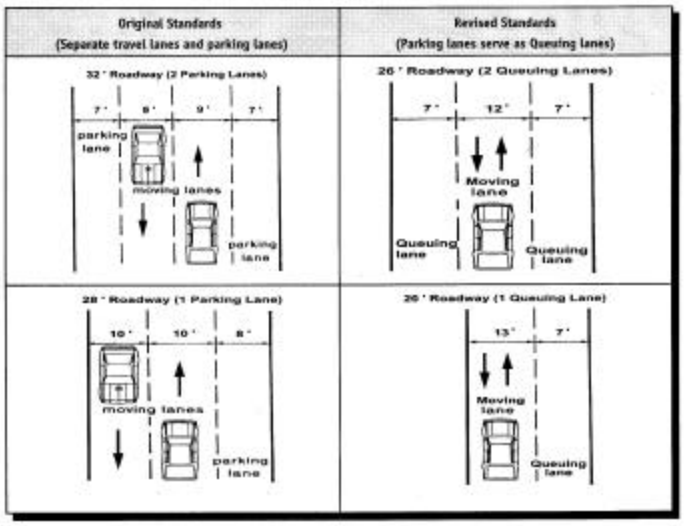


Figure 2: A Comparison of Queuing Streets vs. Traditional Streets (Source: Portland (OR) Office of Transportation, 1994, as found in *Better Site Design: A Handbook for Changing Development Rules in Your Community*, Center for Watershed Protection, 1998)

Streets with queuing lanes provide one continuous lane for travel and when two-way vehicular traffic occurs, one vehicle pulls into the queuing lane until the other vehicle passes by. They are designed for low-traffic residential streets.

Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

Clustering and varied setbacks are tools to meet this goal. Conservation planning, addressed previously is another tool appropriate for use. As with other standards that reduce pavement, this decreases the cost of development.

Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk (where provided), and vegetated open channels for runoff. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.

Many existing right-of-way requirements only address street width. Utilities should be located within the paved area, where possible. This standard allows for more flexible site planning and leaves more land available for housing development. Figure 3 below illustrates design options for consideration.

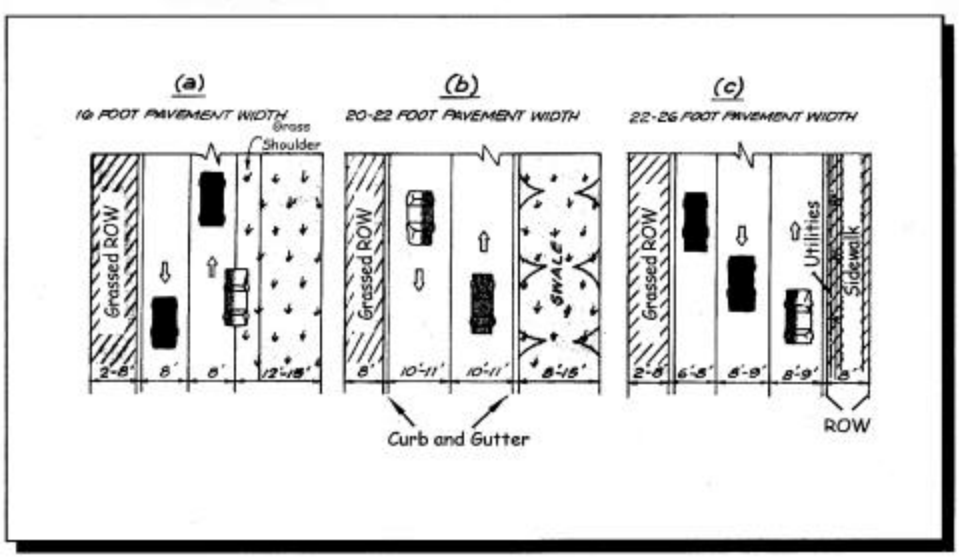


Figure 3: Potential Design Options for Narrower Right-of-Way on Residential Streets (Schueler, 1995, as found in *Better Site Design*)

Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.

Various designs for turnarounds result in less impervious cover. The T-shape generates approximately 75% less impervious cover. Loop roads may be used as an alternative. One benefit of loop roads is that they serve more houses per paved foot, decreasing development costs. These alternative designs and relative impervious cover are illustrated in Figure 4 and Chart 7. Chart 8 shows that streets are the major pollutant source in residential areas, providing evidence of the need to control road area and reduce road runoff.

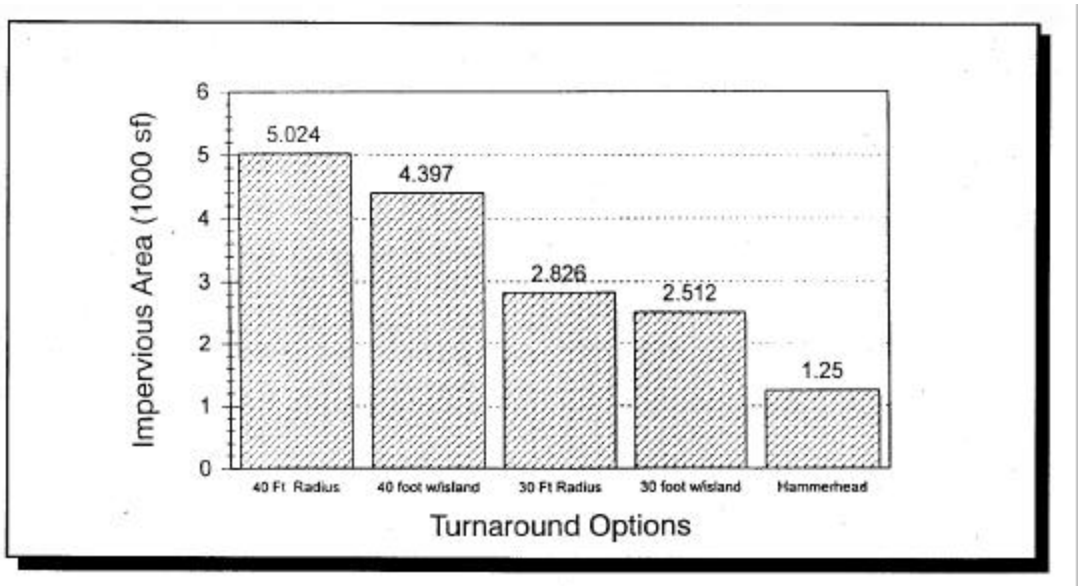


Chart 7: Impervious Cover Created by Various Turnaround Options (Source: Schueler, 1995, as found in *Better Site Design*.)

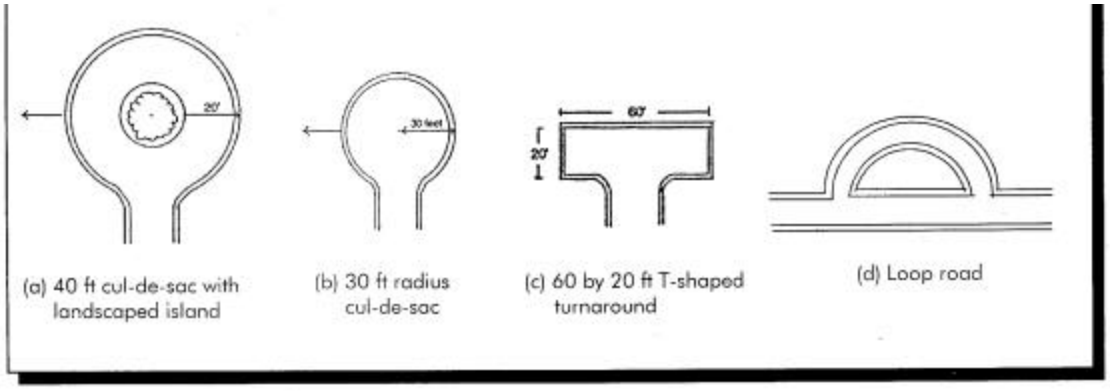


Figure 4: Four Turnaround Options for Residential Street (Source: *Better Site Design*)

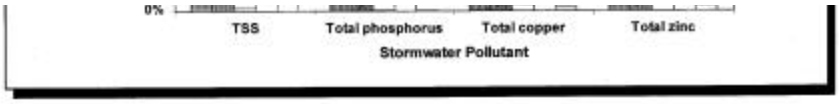


Chart 8: Key Pollutant Sources in Residential Areas (Source: Based on Bannerman and Dodd, 1992, as found in *Better Site Design*)

Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.

Open vegetated channels remove pollutants from stormwater runoff by allowing infiltration and filtering to occur. Open channels also encourage groundwater recharge, and can reduce the volume of stormwater runoff generated from a site. Given that the predominant drinking water source is the individual well, practices that protect the groundwater are consistent with health, safety, and welfare goals of local government. Relative pollutant loads are shown below in Table 5. Pollutant pathways are shown in Figure 5 on the following page.

Table 5: Pollutant Removal Capability of Open Channels using Different BMPs

		Pollutant Removal		
BMP	**Total Suspended Solids**	**Total Phosphorus**	**Total Nitrogen**	**Metals**
Roadside ditch	30%	10%	0	
Grass channel	65%	25%	15%	hydrocarbons: 65% metals: 20 - 50% bacteria: negative
Dry swale	90%	65%	50%	metals: 80 - 90%

Source: Based on Brown and Schueler, 1997, as found in *Better Site Design*

DESIGN STANDARD #2 PARKING REQUIREMENT REDUCTION: DECREASING IMPERVIOUS COVER

Establish maximum as well as minimum parking spaces for developments, taking into account local and national experience. Use compact car spaces, efficient parking

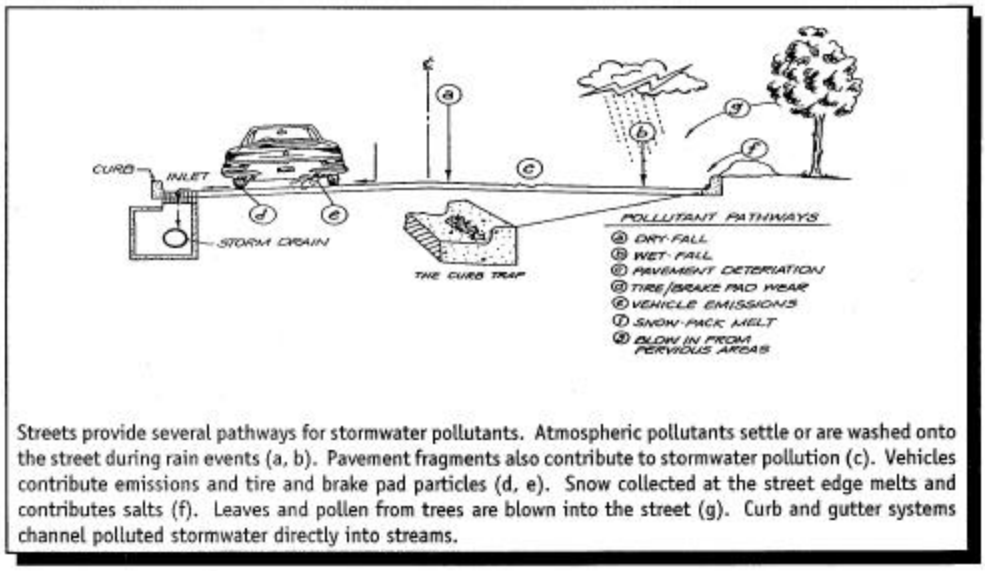


Figure 5: Stormwater Pollutant Pathways (Schueler, 1995, as found in *Better Site Design*)

lanes, and pervious surfaces for spillover parking areas. Lower parking requirements where alternative transportation modes are available or where shared parking is possible.

Existing minimum requirements are often exceeded to avoid complaints regarding adequate parking and to meet lender's requirements, resulting in excessive impervious surface. This can be ameliorated by using creative landscaping, vegetated filters, and meeting peak demands with pervious pavement areas. Setting maximums will decrease cost to the developer and provide better protection to ground and surface waters.

Where pedestrian, bike, or transit alternatives are available, less parking will be required and provide the same benefits to the environment and bottom line. Often a commercial development will contain activities that have different hours of use such as a clothing store and a movie theater. Where combined uses allow, shared parking will reduce the impervious surfaces. Some illustrations are in Table 6.

Table 6: Land Uses with Different Peak Daily Operating Hours

Land Uses with Daytime Peak Hours	Land Uses with Evening Peak Hours
Banks	Bowling Alleys
Business Offices	Hotels (without conference facilities)
Professional Offices	Theaters
Medical Clinics	Restaurants
Service Stores	Bars
Retail Stores	Nightclubs
Manufacturer/Wholesale	Auditoriums
Grade Schools/High Schools	Meeting Halls

Source: *Better Site Design*

Cost and effectiveness are issues to consider when applying any surface for parking. Table 7 illustrates the initial costs, maintenance costs, and effectiveness of various materials commonly used.

Table 7: Summary of Issues Related to Various Types of Alternative Pavements

Material	Initial Cost	Maintenance Cost	Water Quality Effectiveness*
Conventional Asphalt/ Concrete	Medium	Low	Low
Pervious Concrete	High	High	High
Porous Asphalt	High	High	High
Turf Block	Medium	High	High
Brick	High	Medium	Medium
Natural Stone	High	Medium	Medium
Concrete Unit Pavers	Medium	Medium	Medium
Gravel	Low	Medium	High
Wood Mulch	Low	Medium	High
Cobbles	Low	Medium	Medium

* Relative effectiveness in meeting stormwater quality goals
Source: *Better Site Design*

Include on-site stormwater treatment in parking lots using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

Runoff from impervious parking areas carries significant pollutants. These can be removed or reduced through relatively simple mechanisms. Chart 9 shows the pollutant loads that can be expected.

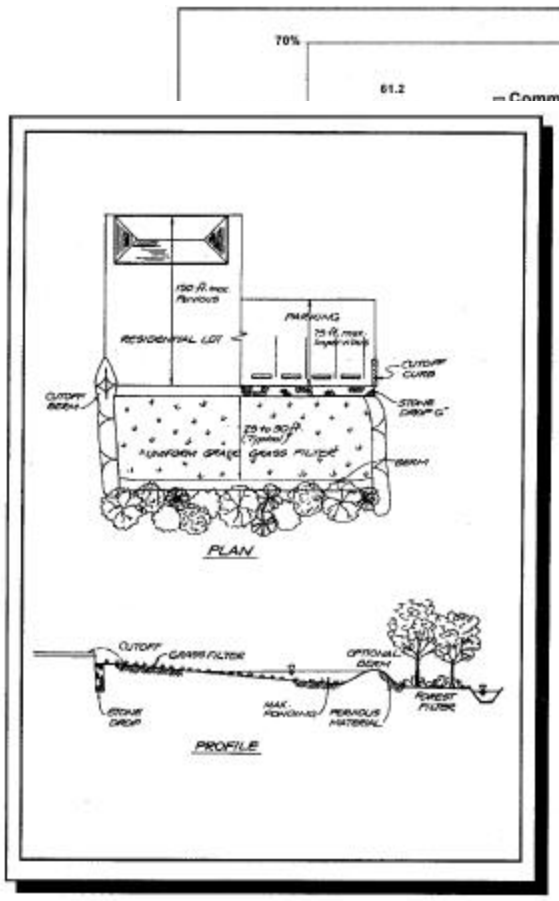


Figure 6: Filter Strips (Source: Claytor and Schueler, 1996, as found in *Better Site Design*)

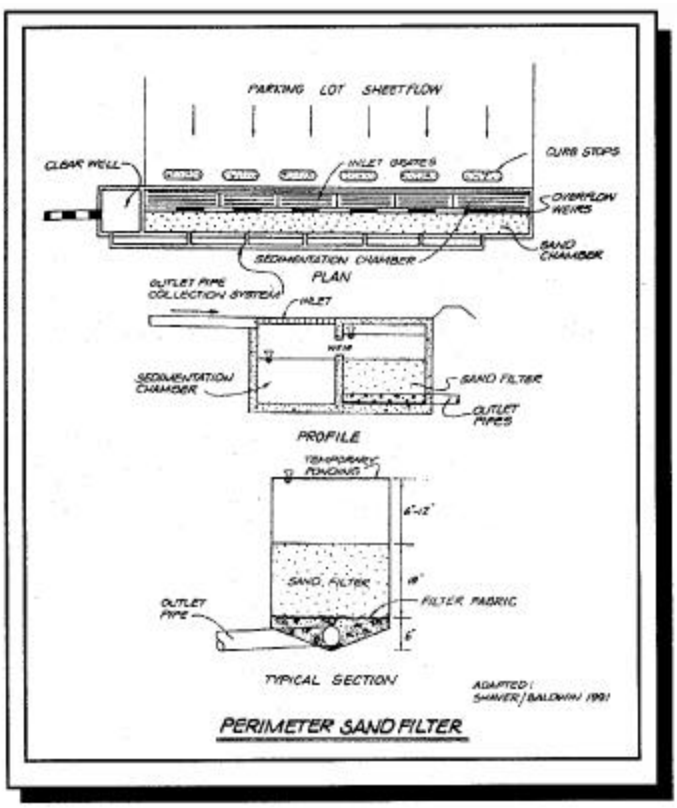


Figure 7: Perimeter Sand Filter (Source: Claytor and Schueler, 1996, as found in *Better Site Design*)

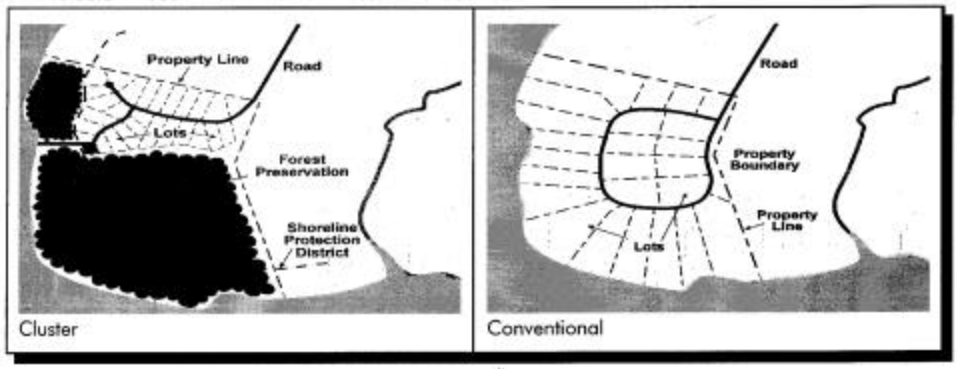


Figure 8: Open space (Cluster) Development versus Conventional Development
(Source: *Better Site Design*)

associated with smaller lots and clustering and found that open space design was selling, costs less to produce, creates a sense of community when linked with bike and pedestrian facilities, is not solely for upper-bracket incomes, and could be

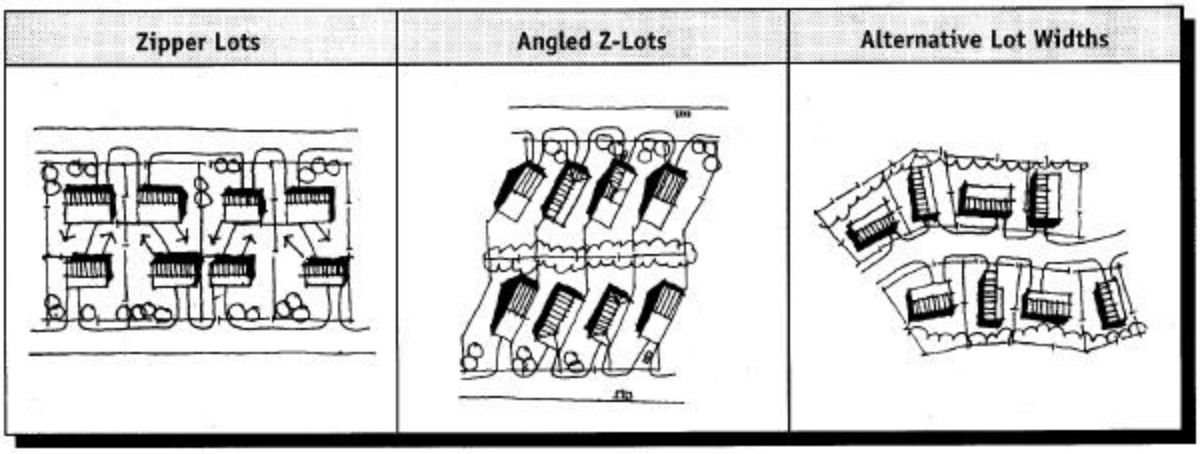


Figure 9: Nontraditional Lot Designs (Source: ULI, 1992, as found in *Better Site Design*)

Use flexible designs for sidewalks, where provided. Consider locating sidewalks on one side and providing common walkways linking pedestrian areas.

In some areas, sidewalks do not make sense. However, where they are appropriate, the impact of the impervious surface can be lessened. Provision of sidewalks and pedestrian safety are closely related.

Promote shared driveways and use of pervious surfaces in subdivisions.

Reduced driveway widths, relaxed front yard setbacks and paving materials regulations can contribute to a decrease in impervious surfaces from driveways. Driveways may account for up to 20% of the impervious cover in a subdivision.

Require clearly specified management for open space areas in developments.

Open space management may take many forms. Because management is important to retaining the value added from the open space, it is best specified in the beginning, to avoid confusion and conflict in post-development. Table 8 lists several options commonly used, along with the pros and cons of each approach.

Table 8: Options for Open Space Management

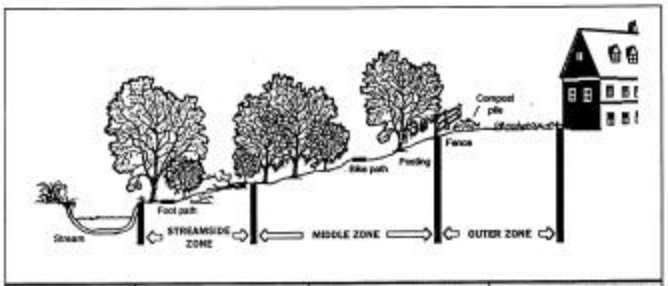
Option	Positive Factors	Limiting Factors
Conservation Easement	guarantees protection from further development may be tax deductible can be tailored to different levels of giving ownership maintained	often not an option for smaller or non-contiguous tracts of land monitoring responsibilities for easement holder owner often expected to make contributions for monitoring
Transfer to Land Trust Ownership	guarantees protection from further development may be tax deductible donator doesn't have to worry about monitoring	loss of ownership often not an option for smaller or non-contiguous tracts of land public use may infringe on residents privacy
Community Association	guarantees protection from further development representation by homeowners	community association fees maintenance and enforcement decisions are reliant on association members
Publicly Owned Land	no additional fees for homeowner not being taxed ensures some certainty over future land use public funds for maintenance	land use decisions may depend on political climate community association interests compete with other groups public use (park) may infringe on residents' privacy

Source: Better Site Design

DESIGN STANDARD #4: USE NATURAL VEGETATION TO MITIGATE EFFECTS OF STORMWATER RUNOFF THROUGH INFILTRATION AND FILTERING.

Direct rooftop runoff into vegetated areas, not the roadway. Require that naturally vegetated streamside buffers be preserved during and after construction activities. Minimize clearing for development and require additional natural plants and trees for adequate buffering of streams.

Naturally vegetated stream buffers provide the best filtration system for stormwater runoff and therefore the best protection for stream water quality. Where possible, they should be retained and protected in the natural state. A second priority is to replace or provide buffers where absent. Figure 10 on the next page depicts how the buffers work to protect water quality. Forest cover, a predominant land cover in the watershed is the most efficient and effective land cover for protecting the water quality in streams.



Characteristic	Streamside Zone	Middle Zone	Outer Zone
Width	Minimum 25 feet plus wetlands and critical habitats.	50 - 100 feet depending on stream order, slope, and 100-year floodplain.	25 foot minimum setback from structures.
Vegetative Target	Undisturbed mature forest. Reforest if necessary.	Managed forest, some clearing allowed.	Forest encouraged, but usually turfgrass.
Allowable Uses	**Very Restricted** e.g., flood control, utility right-of-way, footpaths	**Restricted** e.g., some recreational uses, some stormwater BMPs, bike paths, tree removal by permit	**Unrestricted** e.g., residential uses including lawn, garden, compost, yard wastes, most stormwater BMPs

Three lateral zones comprise the foundation of an effective urban stream buffer zone. The width, function, management and vegetative target vary by zone.

Figure 10: The Three-Zone Urban Stream Buffer System (Source: Adapted from Welsch, 1991, as found in Better Site Design.

The benefits of stream buffers are listed in Table 9 below.

Table 9: Benefits of Stream Buffers

1. Reduces small drainage problems and complaints	10. Prevents disturbances to steep slopes*
2. Allows for lateral movements of stream	11. Mitigates stream warming*
3. Provides flood control	12. Preserves important terrestrial habitat*
4. Protects from streambank erosion*	13. Supplies corridors for conservation*
5. Increases property values*	14. Essential habitat for amphibians*
6. Enhances pollutant removal	15. Fewer barriers to fish migration
7. Provides a foundation for present or future greenways	16. Discourages excessive storm drain enclosures/channel hardening
8. Provides food and habitat for wildlife*	17. Provides space for stormwater ponds
9. Protects associated wetlands	18. Allows for future restoration

Source: Better Site Design *benefit amplified by or requires forest cover

VII. Appendix One – Existing Studies

Summary of Virginia Power Lake Anna Plan

When the Lake was being formed in 1971, Virginia Power prepared a Land Use Plan that set forth a cooperative approach to orderly development at the Lake. The approach intended to take advantage of the recreational opportunities provided by the Lake and to protects the water quality and the cooling basins. Following is a summary of the recommendations contained in the Plan and a description of what has and has not been done to conform to those recommendations.

GOALS OF PLAN:

- Maintain the quality of water.
- Maintain quality of natural environment.
- Preserve rolling pastoral nature of the Lake landscape within the context of orderly growth and development.

GOALS DEPEND ON:

- Site conditions,
- Land ownership,
- Buyer preferences, and
- Local planning regulations.

MAJOR CHANGES DUE TO LAKE FORMATION:

- Creation of Lake
- Creation of power plant
- Future land use changes

Objective of Environmental Analysis: To determine the best locations for future development. This resulted in the Land Use Plan.

PREDICTIONS:

Region's year 2000 population projections:

- Drawing area: 3,403,000 (Mid-Atlantic States)
- Three counties: 44,220 (1970), 51,100 (1980), 59,400 (1990), 70,200 (2000) (Actual growth far exceeds these Center for Public Service estimates and past Census population counts)

- Year 2000 Recreation Demand days: 853,000,000 (Commission on Outdoor Recreation)
- Visitors (when facilities built): 855,000-1,339,000; by 2000, 1.5-2.3 million
- Picnicking increase 30% by 2000; camping and hiking by 97%
- Recreational activity by 2000, 2.3 to 2.5 million
- Major demand, large, intense development, especially for lake-side homes
- Lower levels of farm soil erosion anticipated, accompanied by lower levels of pesticide runoff
- Manufacturing will increase and stimulate growth in surrounding counties
- Three counties will continue to be major commuting localities
- Lake will become a magnet for vacation home development, resulting in major land subdivision which, if done improperly, will result in costs to the locality in which it occurs. Predict 500-750 lot sales/year until 1981, slowing after that.
- Homes will be stick built or mobile homes
- 4,500-6,000 homes projected by 2000. Of these about 1,500 will be permanent homes.
- Commercial activity will increase around the Lake and in Mineral and Louisa, mostly new business growth. (7-9 business/100 permanent and vacation homes)
- Four day work week fast approaching

FINDINGS:

- In 1969, 64% of Orange County in farmland; 60% of Spotsylvania; and 40% of Louisa
- In 1969, 75% farm income from livestock and livestock products
- Farmland acreage is decreasing, as is the number of farms. However, acres per farm have increased.
- Due to former mining activities, acid runoff in Contrary Creek poses a threat to water quality
- 75% of soils present few restrictions (Appling)
- Existing development sparse
- Total shoreline, >200 miles
- Minimum instream flow requirement: 40 cu ft/sec
- Principal impact from power plant will be heat discharge.

- Shallow littoral zones, with sunlight penetration, will foster rich vegetative growth
- Water skiing, speed boating and sailing will be restricted to the general area between the dam and plant site.

RECOMMENDATIONS:

Where Virginia Power plan recommendations have been implemented, an "I" follows the recommendation; where they reappear in this plan, an "R" follows; where not done, an "N" follows.

I. Avoid trouble from the start

   A. Manage future growth – "How can good land development be ensured? By good planning first, and by proper zoning and subdivision controls; by good building codes and health regulations; by erosion controls and other means, but particularly by setting high standards for development and sticking to them."

      1. Initially zone all land at lowest density (N)
      2. Prepare detailed environmental studies and development scheme for each peninsula. (N)
      3. Create Lake planning commission and advisory citizens group (I/R)
      4. Consider regional Park Authority (N)
      5. Institute similar land use and pollution control programs (I/R)
      6. Examine potential for easements to manage development (N)
      7. Use mobile home parks or PUDs rather than scattered site locations (I/R)
      8. Encourage formation of homeowners associations (I)
      9. Create an *ah hoc* committee of state agencies to assist localities (N)

   B. Retain pastoral, quiet landscape quality (R)

   C. Request state re-classify Lake from Class 111A to 111B (N)

II. Provide both general public and private access (N/R)

III. Cluster business activity to provide the greatest benefit, locations recommended. (R)

   A. Create three business centers (small shopping for basic needs of residents)

   B. Create resort centers (marina, restaurants, motels/lodging, golf, private launches integrated with housing development)

IV. Discourage industrial uses around Lake. They would best locate away from Lake or be fully compatible with recreational importance of Lake. (R)

V. Adopt environmental guidelines and ordinances in each locality. (I/R)

- A. Planning commissions use Virginia Power studies as basis for regulations and ordinances.
- B. Cluster development for efficient provision of services
- C. Reduce or eliminate strip boat dock shoreline development.
- D. Use Planned Unit Development (PUD) concept for resort development
- E. Buildings should be high enough and far enough back from shore to avoid the consequences of severe winds and waves.
- F. Use stabilization ponds or lagoons for domestic waste to address high nitrogen concentrations in Lake
- G. Prepare and implement comprehensive water and sewer plans in watershed
- H. Locate source of high coliform count in Goldmine Creek and eliminate discharge
- I. Adopt regulations for disposal of boat waste
- J. Ban industrial discharges into contributing streams
- K. Clean up Contrary Creek by eliminating acid discharge
- L. Implement soil and erosion control plans
- M. Educate citizens about pesticide and fertilizer pollution potential
- N. Implement program to encourage use of stream buffers and other BMPs
- O. Keep wells and septic fields apart from each other

VI. Relate development to overall concept of sewer, water, road, water access, and public service needs for each peninsula. (N/R)

- A. High density (1-2du/ac), public water and sewer
- B. Medium density (1du/1-4 ac), community water and sewer where septics not suitable.
- C. Low density (1du/5+ac), wells and septics are suitable

VII. Locate one park in Louisa, one in Spotsylvania in addition to the State Park (2,500-2,600 acres). It is not desirable to only have one park on the Lake. (N)

VIII. Provide six public access points (N)

IX. Place land adjacent to littoral zones of Lake in conservation zones. (½I)

X. Establish monitoring program to reduce pollution from runoff. (R)

XI. Improve roads with VDOT using a 5-10 year funded program: (R)

- A. Create circumferential road system
  1. includes: Routes 653 and 601; 652 and 208; 533, 719, and 652.
  2. all roads should conform to same minimum standards
  3. billboards should not be allowed.
  4. build additional road across the second dike
- B. Major and minor feeder roads should be brought up to standards consistent with projected traffic loads.

XII. Consider joint regulations for water use: (N)

- A. Limit horsepower of boats in fishing areas,
- B. Ban powerboats from beach and swimming areas
- C. Direct water skiing to large expanses, away from narrow areas, beaches, and marinas.

XIII. Consider inter-local agreements for public safety services such as fire, safety, health services, schools and police protection both on and off water. (I)

Summary of Louisa County Comprehensive Plan

The 1993 Comprehensive Plan was amended in 1998 and is currently under review. The Lake is envisioned as an area of the County that will experience future growth because of its recreational value and because of its proximity to Fredericksburg. The plan calls for directed growth patterns.

A 1998 amendment to the Plan calls for Louisa County to work with Spotsylvania and Orange Counties to develop a master plan for the Lake Anna area and to limit development densities until such time as the Plan revision is completed. The amendment calls for continued evaluation of the long-term effects of growth, opportunities for watershed management, infrastructure and open space plans, proffer opportunities, and growth phasing priorities.

Lake Anna is seen as recreational/resort development of seasonal and mixed uses; seasonal activities oriented toward Ware's Crossroads and year-round growth oriented toward a Village Center at Buckner/Bumpass. Recommendations include evaluation of existing regulations and the necessity for additional resort/residential guidelines.

The Lake Anna area of the County is very diverse both environmentally and culturally. Much haphazard development has taken place since the construction of the lake. If current trends continue, the water quality of the lake will decrease, destroying the very thing that creates economic value in this area. This most likely would result in a decrease in property values, which could have a serious negative effect on the County tax base. In an effort to prevent this, the County should proceed with Spotsylvania and Orange Counties to develop a land use master plan for the Lake Anna Area. Until such time that this study has been complete, development densities are recommended to be limited to that which can be served safely by individual well and septic systems.

As might be expected, the plan envisions opportunities for water-related commercial uses. Areas noted include each end of the Lake, and at the arterial crossing of Route 208, Dike #3 at Route 622, and suggests other opportunities be investigated. The Plan warns that as the Lake area is developed privately, public access may be eliminated compromising future community Lake use.

Road improvements suggested include a new link between Routes 522 and 700 to open up circulation and avoid excessive intersections on Route 522. It is envisioned this would be built in conjunction with private development.

Summary of Orange County Comprehensive Plan

The Orange County Plan was adopted in September 1999. Little is said in the Orange County Plan specifically about the Lake. Most of the watershed is in agricultural land use for the future, with industry southwest of the Town of Orange, and Town Centers around the Towns of Orange and Gordonsville.

Currently the Orange County portion of the Lake Anna watershed is comprised primarily of agriculturally zoned land, with scattered single family development. Preliminary results of a build-out study being conducted for the county by the Piedmont Environmental Council (PEC) reveal that approximately 80% of the land in the Orange County portion of the Lake Anna watershed has a density of one dwelling per 49 acres.

The Plan addresses the issues of non-point source pollution control and reduction using BMPs in conjunction with the Soil and Water Conservation Districts. Currently BMPs and BMP plan development costs are shared, with the state providing half the funds. The problem with this is that the state funds are not adequate to complete the tasks at hand. With a new part-time Planning Assistant hired by the County, the enforcement of the Erosion and Sediment Control ordinance has improved, helping to reduce the impact of any off-site sedimentation which might occur as the result of new construction.

County ordinances require a minimum lot size of 2 acres and allow by-right subdivision of a parcel into 4 lots every 4 years. Based on this, preliminary results of the PEC build-out study show an overall projected development density in the watershed of one dwelling per every lot that is 2-9 acres in size (assuming 100% build-out). More dense development, such as commercial and industrial development, is projected to occur at the extreme fringe of the watershed if current zoning standards are applied. The future land use map in the revised Comprehensive Plan (1999) shows the Orange County portion of the Lake Anna watershed as Agricultural or Open Space.

Subdivisions in Orange County in the Lake Anna watershed to date have been comprised mostly of single lot divisions or cluster housing developments. For cluster developments, the tract must be at least 30 acres in size, 75% or which must be reserved for open space, with one acre lots allowed in the remaining 25% to be developed. The cluster housing development provisions require the reserved area to be held in common as one parcel. Recently, the County's zoning ordinance was changed such that subdivisions with 5 or more lots must have roads built to state standards and that 10 or more acres constitute a major subdivision and require hydrologic testing.

The Plan does not envision the Lake area as a high growth area, but sees agriculture and open space remaining as the major land uses. The farming community, with education about the BMPs and the savings available to them under the various state programs are seen as good stewards of the land.

Summary of Spotsylvania County Comprehensive Plan

The Lake Anna Resort District is one of six "planning districts" of the County. It is designated in order to insure that development that occurs around Lake Anna is in keeping with the natural character and beauty of the area. The district allows for the development of a village at the southern end of Route 208 before the bridge crosses the Lake. To quote the Plan, "Development within the Lake Anna Resort District is intended to enhance the economic benefits derived from the Lake while preserving the rural resort character of the area. Water quality protection, storm water management and environmental protection will be key components of new development around the Lake." The scenic beauty of the Lake, the view sheds, minimizing storm water runoff, and pollution risks to the Lake are seen as important.

"Special districts," another planning district, are recommend to direct growth in new areas. The proposed Lake Anna Village Center is one of these areas. Development underway is seen as of sufficient scale to be considered villages. The Lake Anna Village Center will reflect the unique environmental end economic conditions that apply to the area. Infrastructure will be limited to Village Centers and not provided outside of these areas.

The Plan names Lake Anna as one of the County's most valuable recreational resources, attracting thousands of visitors. Water sports of all kinds are enjoyed on the Lake.

The Plan includes development standards for a Lakeside Village and the Resort District. While no road improvements are cited, should there be road improvements, they are to be implemented with environmental constraints to prevent runoff.

Promotion of the State Park, studying the feasibility of a conference center at the Lake, creation of economic development areas for tourism and resort type uses are suggested. It is also acknowledged that fire and rescue services will need to be adequate for resident's safety and that expansion of the library system into the Lake area may be called for in the future.

VIII. Appendix Two – Detail of Supporting Data

Calculation of Accelerated Erosion Rate

Soil erosion rates, exclusive of rill (small gullies less than 6 inches) and gully, can be measured or predicted by using the Universal Soil Loss Equation developed by the U.S. Agricultural Research Service or a variation of the equation. Rill and gully erosion is measured by computing the cubic area. Used one way the equation can establish the potential of a soil to erode if disturbed. Used another way it can measure the amount of annual soil loss for a field or series of fields. Thus watershed maps or tables can be produced which show the erosion potential or actual erosion rates in a specific use situation.

County Soil Survey Reports produced by the USDA Soil Conservation Service, now the Natural Resource Conservation Service, provide information to establish soil loss tolerances or T values for each soil type. The soil's T value indicates the annual amount of soil that can be lost by erosion without reducing the inherent capability of that soil to produce vegetation. In other words, the T value is the balancing point between annual soil loss and annual replacement rates.

Accelerated erosion which exceeds the soil's T value slowly destroys that soil and its productive capability. Soil types within the Lake Anna watershed have T values that range from 2 tons per acre per year to 5 tons per acre per year, with 3 tons being average. Actual measured erosion rates within the watershed range from being within the T value to 5 or more times the T value. This latter amount represents a significant loss in productive capability over time.

Dry weight of soil varies considerably depending upon texture. On the average a one-inch loss over an acre of exposed soil amounts to a soil loss of 150 tons per acre. Under actual conditions a field of exposed soil does not erode uniformly over the entire area. Some of the exposed area may not have any soil loss while another part of the field may have a loss of 45 tons. Lastly, there may be a portion of the field that is flat and received the soil loss from the eroding portions of the field. If the soil in this field had a T value of 3 and was 5 acres in size the soil loss for the field would be stated as 2T.

Estimated erosion rates in acres and tons of erosion are displayed in the following tables.

Table A2-1. 1995 Estimated Acreage by Erosion Rate Category

Use	<T	T-2T	>2T
Cropland	1,035	8,133	3,531
Grassland	28,982	24,130	2,281
Forest land	102,449	13,130	4,407
Residential	11,000	242	200
Disturbed sites	0	128	36
All other	1,100	528	504
Total	**144,566**	**46,921**	**10,959**
Percent	**71.6**	**23.0**	**5.4**

Table A2-2. 1995 Estimated Tons of Erosion by Erosion Rate Category

Use	<T	T-2T	>2T
Cropland	1,448	44,466	63,122
Grassland	23,190	120,647	36,378
Forest land	30,735	36,764	20,713
Residential	770	1,210	3,000
Disturbed sites	0	1,024	680
All other	77	2,540	8,000
Total	**56,220**	**206,751**	**131,893**
Percent	**14.2**	**52.4**	**33.4**

Table A2-3. Potential Erosion Reduction

Total Annual Average Erosion Tons	**394,864**
Excessive Erosion Tons (T-2T and >2T)	**338,644**
Realistic Potential for Reduction Tons (Based on voluntary, not regulatory efforts - 63% of excessive total as follows: 50% of crop and grassland, 20% forest land and 12% of all other lands subject to excessive erosion)	**212,863**

Source: Virginia DCR, Division of Soil & Water Conservation, except for grassland erosion rates which were computed by Gerald Root due to error of omission in original data.

Shoreline Erosion

The Lake Anna shoreline is over 200 miles long. From map measurement, approximately 6 miles (3%) are protected by concrete or heavy riprap and are non-erosive. This includes bridge abutments, concrete boat launch ramps and the canals and dikes. The remaining 97% are subject to erosion even though smaller riprap or wooden bulkheads protect some of the remaining shoreline. Unless these areas were protected by an erosion resistant fabric prior to the installation of stone or wood, some erosion of the finer soil particles occurs annually. Erosion from these areas averages 5 to 15 tons per mile annually. Approximately 20 % of the shoreline is protected by stone or wood. Table A2-4 displays an estimate of shoreline erosion rates based upon visual observations of 50 percent of the lake's shoreline that was then expanded to the entire shoreline.

Table A2-4. Estimated Shoreline Erosion Rates

Erosion Rate	Miles	Tons/mile	Erosion Rate
Non Erosive	6	0	0
Very Slight	54	10	540
Slight	64	20	1,280
Moderate	88	50	4,400
Severe	60	150	9,000
Total Tons	**272**	_	**15,220**

Source: Visual observations, map measurement of distances of various sediment categories on sample area expanded to entire lake, not statistically reliable.

Impervious Surface

Table A2-5: Approximate impervious surface values for various land covers

Land Cover	% Impervious Surface
Forest	0 (baseline)
Ungrazed grass/shrubland	2
5+ acre residences in woodlands	3
2-5 acre residences in woodlands	5
Mowed lawns, moderately grazed pasture, golf courses	8
1.0 acre residences	10
Orchards	12.5
Grazed pasture lands	15
Croplands	25
0.5 acre residences	25
0.33 acre residences	30
0.25 acre residences	35
Townhouses	50
Apartments	70
Light Commercial/Industrial/Schools/University	70
Heavy Commercial/Industrial	90
Pavement, Quarries	100

Source: *State of the Basin: 1998*, Rivanna River Basin Project, 1998.

Codes and Ordinances

Table A2-6: Comparison Table for Codes and Ordinances in Lake Anna Watershed

Development Category	Louisa		Orange		Spotsylvania	
	answer	points	answer	points	answer	points
minimum pavement width for streets < 500 ADT (feet)	14	4	no regs	4	18	4
parking lanes can serve as traffic lanes	Y	3	N	0	N	0
standards promote most efficient street layout	Y	1	N	0	Y	1
minimum right-of-way (feet)	50	0	50	0	40	3
utilities allowed under paved ROW	Y	1	N	0	N	0
minimum cul-de-sac radius (feet)	35	3	50	0	45	1
island allowed within cul-de-sac	Y	1	N	0	N	0
“hammerheads” allowed	Y	1	N	0	N	0
curb and gutter required	N	2	N	2	N	2
design criteria for swales for stormwater quality treatment	N	0	N	0	Y	2
minimum parking ratio for professional office building	2.5	1	6	0	3.3	0
minimum parking ratio for shopping center	2.5	1	4	1	4.0	1
minimum parking ratio for single-family home	1	1	2	1	2	1
parking requirements maximum or median (rather than minimum)	N	0	N	0	N	0

Development Category	Louisa		Orange		Spotsylvania	
	answer	points	answer	points	answer	points
use of shared parking arrangements promoted	N	0	N	0	Y	1
model shared parking agreements provided	N	0	N	0	N	0
parking ratios reduced if shared arrangements in place	N/A	0	N	0	N	0
parking ratios reduced if mass transit nearby	N/A	0	N	0	N	0
minimum stall width for standard parking space (feet)	9	1	9	1	8.5	1
minimum stall length for standard parking space	18	1	18	1	18	1
at least 30% of large commercial lot spaces required to have smaller dimensions for compact cars	N	0	N	0	N	0
pervious materials allowable in spillover parking areas	Y	2	Y	2	Y	2
incentives for use of parking garages	N	0	N	0	N	0
minimum % of parking lot required to be landscaped	N	0	Y	2	Y	2
bioretention islands, etc. allowed within landscaped areas/setbacks	N	0	Y	2	Y	2
open space/cluster design allowed	Y	3	Y	3	Y	3
land conservation/imperviousness reduction is major goal of open space design ordinance	N	0	Y	1	Y	1

Development Category	Louisa		Orange		Spotsylvania	
	answer	points	answer	points	answer	points
review requirements for open space design greater than for conventional	N	1	N	1	N	1
open-space design is by-right	Y	1	N	0	Y	1
flexible site design criteria available	N	0	N	0	Y	1
irregular lot shapes allowed	Y	1	Y	1	N	0
minimum requirement for front setbacks (acre lot) (feet)	60	0	35	0	30	0
minimum requirement for rear setbacks (acre lot) (feet)	no answer		25	1	5	1
minimum requirement for side setbacks (acre lot) (feet)	no answer		8	1	10	0
minimum frontage distance for acre lot (feet)	no answer		70	2	80	0
minimum sidewalk width (feet)	no regs	2	no regs	2	4	2
sidewalks always required	no regs	2	no regs	2	N	2
sidewalks sloped to drain to front yard	no regs	0	no regs	0	Y	1
alternate pedestrian networks substitutable for sidewalks	no regs	1	no regs	1	Y	1
minimum driveway width (feet)	no regs	2	no regs	2	12	2
pervious single-family driveways allowed	Y	2	Y	2	Y	2
two-track driveway allowed	Y	1	Y	1	N	0

Development Category	Louisa		Orange		Spotsylvania	
	answer	points	answer	points	answer	points
shared residential driveways allowed	Y	1	Y	1	Y	1
enforceable requirements for open space management associations	N	0	Y	2	Y	2
open spaces required to be consolidated	N	0	Y	1	N	0
minimum % of open space must be managed in natural condition	N	0	Y	1	N	0
allowable uses for open space defined	Y	1	Y	1	Y	1
open space can be managed by third party w/trust, easement	N	0	Y	1	Y	1
rooftop runoff can be discharged to yard	Y	2	N	0	Y	2
temporary ponding of stormwater on front yards, rooftops allowed	Y	2	N	0	Y	2
stream buffer ordinance	N	0	Y	2	Y	2
minimum buffer width (feet)	N/A	0	50	0	100	1
expansion of the buffer to include wetlands, slopes, floodplains required	N/A	0	N	0	Y	1
stream buffer must contain native vegetation	N/A	0	N	0	Y	2
allowable uses for buffer outlined	N/A	0	N	0	Y	1

Development Category	Louisa		Orange		Spotsylvania	
	answer	points	answer	points	answer	points
enforcement/education mechanisms for buffer specified	N/A	0	N	0	Y	1
preservation of natural vegetation during residential development required or encouraged	N	0	Y	2	Y	2
reserve septic fields need to be cleared at time of development	no answer	0	N	1	N	1
trees required to be preserved in residential development	N	0	N	0	N	0
limits of disturbance on plans adequate for preventing clearing	no answer	0	N	0	Y	1
incentives for land conservation	N	0	N	0	N	0
flexibility to meet regulatory, conservation restrictions offered	N	0	N	0	N	0
stormwater required to be treated for quality before discharge	N	0	N	0	Y	2
design criteria for stormwater BMPs	N	0	N	0	Y	1
stormwater can be directly discharged into wetland	Y	0	Y	0	N	1
development in floodplain restricted/prohibited	Y	2	Y	2	Y	2
Total		**47**		**50**		**69**

The highest possible score is 100. From 60-69, the Center observes that development rules are inadequate to protect the local aquatic resources and a site planning roundtable would be useful in determining how to improve the ordinances. Below 60, a full review of the ordinances in light of environmental issues should take place. This could be done through the establishment of a development roundtable including planners, developers, technical experts, and citizens, with recommendations to the planning commission and then to the local Board of Supervisors.

IX. Appendix Three – Planning Tools

The Eight Tools of Watershed Protection

The eight tools of watershed protection are an organizing principle, developed by the Center for Watershed Protection, for methods of maintaining water quality on a watershed scale. Much of the following material has been adapted from the Center's manual, *Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds (October 1998).*

The eight tools are:

- Watershed Planning
- Land Conservation
- Aquatic Buffers
- Better Site Design
- Erosion and Sediment Control
- Stormwater Best Management Practices (BMPs)
- Non-Stormwater Discharges
- Watershed Stewardship Programs

WATERSHED PLANNING

A watershed plan establishes the framework for the other tools of watershed protection. It is important to determine early in the process which stakeholders should be involved in the planning, which organization will administer the plan, and what financial resources are available. The foundation of the plan should be an assessment of present and historic conditions. Development of an impervious cover map is an important aspect of this. Once existing conditions and trends are determined, the next step is to project future impervious surface, based on zoning, future land use maps, and development patterns. What will the effect on water quality be if development continues along current lines? Goals should be set. Example watershed goals include water quality maintenance or restoration, flood control, provision of habitat, and provision of parkland or trails. A large watershed should have goals set for its subwatersheds, as well as for the overall watershed. Indicators or benchmarks should be established to track success in achieving goals.

Achievement of goals may involve redirecting development through zoning tools. Some examples of zoning tools include watershed-based zoning, overlay zoning, incentive zoning, and large lot zoning. Land use planning should be combined with the other tools of watershed protection to form an integrated strategy for meeting the goals. Maps should not be underestimated as a tool for communicating the plan. Additional studies may be necessary (for example, an inventory of erosional areas along banks, or determination of fecal coliform sources), but implementation of

some basic watershed protection measures should be possible before all studies are complete. The plan should be revisited periodically to review new information and assess progress made toward goals.

LAND CONSERVATION

Certain areas in a watershed may be determined during the planning process to be of special importance to preserve. These include:

- Critical habitats such as wetlands, coves, spawning areas, or unbroken areas of mature forest;
- Aquatic corridor areas such as shorelines, floodplains, steep slopes, and stream channels;
- Hydrologic reserve areas that maintain the predevelopment hydrologic response of a watershed, such as forest, pasture, and crops;
- Cultural and historic sites that provide a sense of place such as historic areas, scenic views, and parkland.

Areas may easily fall into more than one category. Land conservation methods can include land acquisition, conservation easements, land alteration regulations (such as a ban on fill in wetlands), open space design/conservation planning, and stewardship (tool #8).

In addition to the protection of desirable areas, provision of setbacks, buffers or other means of separating land uses with high pollution potential from waterways should be considered. Examples include septic systems, landfills, storage tanks, industrial areas, and areas in which fertilizers and pesticides are applied.

AQUATIC BUFFERS

In recognition of the value of trees in controlling site runoff and the need for vegetated buffers, the Virginia Department of Forestry's *Forestry Best Management Practices for Water Quality in Virginia* handbook recommends Stream Management Zones (SMZ) on both sides of the banks of perennial streams, rivers and bodies of open water in order to protect bank edges and water quality. Vegetated buffers (or "filters") of trees, shrubs and grasses have been shown to slow storm water runoff and encourage percolation, thus reducing the volume of storm flow, while filtering 70 - 80% of water borne pollutants. "Buffer strips create stable stream flow, stabilize stream banks, reduce suspended sediment and turbidity, lower summer water temperatures, and filter chemical and organic pollution. They can also slow topsoil loss from agricultural areas, combined with erosion prevention practices on farmland. A healthy riparian zone also benefits terrestrial wildlife." (Waters,

Sediment in Streams.) Buffer areas would serve to reduce sediment and phosphorus runoff, which are or have the potential to be problems in the Lake Anna watershed.

BETTER SITE DESIGN

The impervious surface values given for various land cover types in Table A2-5 reflect typical values for typical development patterns. However, impervious surface cover can be reduced, open space increased, and runoff from those impervious surfaces that must be retained can be cleansed by the use of better site design principles. These principles include reduction of size of streets, parking lots, and driveways; use of pervious materials for spillover parking and driveways; open space (cluster) design of subdivisions; tree conservation; and stormwater management. Development rules, such as subdivision codes and zoning regulations, may need to be changed to allow better site design principles to be practiced.

EROSION AND SEDIMENT CONTROL

The comparatively brief period during site clearing, grading and construction of a new road or commercial, industrial, or residential development is often the most destructive. Not only is this likely the period in which most erosion will occur, but trees, vegetation, and topsoil may be cleared, and drainage patterns possibly changed. Erosion may be reduced by following state and local standards, which are based on the following principles:

- Reduce the area of exposed soils to the minimum possible.
- Reduce the time of exposure.
- Divert runoff water away from the exposed areas.
- Reseed and mulch the area as soon as possible after completion of the earth disturbing activity. If weather conditions are not suitable for seeding, use a dormant seeding or just mulch until the area can be reseeded or surfaced with erosion-resistant covering.

Clearing restrictions, or incentives to reduce clearing, should be considered. Whether sufficient staff resources are available for erosion and sediment control (ESC) inspections, and how well the ESC standards work with other watershed protection tools, such as buffers and better site design, should also be evaluated.

STORMWATER BEST MANAGEMENT PRACTICES (BMPS)

Some of the damage done to stormwater quantity and quality by development may be ameliorated by the use of stormwater best management practices. Installed and maintained properly, stormwater BMPs may reduce pollutant loads, reduce flooding, prevent erosion, and contribute to groundwater recharge. Major types of stormwater

BMPs include ponds, wetlands, infiltration and filtration areas, and vegetated channels. BMPs are never 100% efficient; for example, the Chesapeake Bay Watershed Model uses estimates of 20% - 64% removal of phosphorus and 20% - 80% removal of sediment for various stormwater management BMP options. Maintenance of BMP facilities is critical to their continued effectiveness. Responsibility for BMP maintenance should be determined and guaranteed.

NON-STORMWATER DISCHARGES

Septic Tanks

EPA has identified septic systems as the most frequently reported sources of groundwater contamination in the United States. The contaminated groundwater can, in turn, contaminate surface water as the groundwater recharges surface water during dry weather.

Septic systems function by providing both anaerobic (without oxygen) and aerobic (with oxygen) treatment of biological wastes. Microorganisms provide this treatment. Anaerobic processing occurs within the septic tank. Each time the septic tank fills up, the overflow goes first into a distribution box and then into parallel lines of perforated pipe or open-jointed tile. These “lines” are placed in trenches partially filled with gravel and completely surrounded by soil. These trenches make up the drain field of a conventional septic system.

Aerobic treatment of the wastewater takes place in the soil of the drain field. If the septic tank is not pumped out, it will eventually fill up with solids. Solids will begin to be transported into the trenches and, over time, will clog the soil pores. Septic system failure will occur when sufficient solids have infiltrated into the soil pores to cause sewage to leach out onto the surface or back up into the residence that the system serves. Rehabilitation of a drain field that has failed due to solids infiltration is often either impossible or ineffective, and is extremely expensive even where it can be done. In addition, long before this type of failure occurs, inefficient treatment of the wastewater may have occurred for a number of years. The EPA recommends an average pump-out frequency of three to five years for conventional septic systems in order to maintain efficient effluent treatment.

Pump-out alone will dramatically extend the life of a sewage disposal site. Nevertheless, failure will take place eventually although with very different consequences. In conventional drain fields, a biological mat builds up at the gravel/soil interface in the drain field trench. After many years, this mat, which is very important for providing treatment of the effluent wastewater, becomes too thick for water to pass through it. System failure will occur in this situation as with a system that has not been regularly pumped out.

System failure caused by biological mat buildup alone is not permanent. If solids have not infiltrated into a disposal site or if components of the on-site sewage treatment system have not been damaged, the disposal site can often be reclaimed merely by temporary cessation of use, allowing the biological mat time to break down. The amount of time necessary to reclaim a sewage disposal site in this manner may be very brief or as long as several years, depending on the amount of biological mat buildup. For this reason, a reserve area should be available in order to continue the use of a given system and maintain residency on an affected property. Regularly switching between two fields can, combined with regular pump-out, result in greatly extending the useful life of a septic system. However, careful siting of a septic system is also important, because an improperly sited system can result in groundwater contamination even when it is functioning properly.

Sanitary Sewers

There are currently no sanitary sewers in the immediate vicinity of Lake Anna, although sewer service has been proposed for a potential village center and is available in towns at the edge of the watershed. Sanitary sewers often result in considerably lessened amounts of nutrient and bacterial pollution as compared to septic systems, but this is not always the case. Pollution problems may arise from package treatment plants, overflows, leaking pipes, and illegal connections to storm drains.

Other Sources

Sources of non-stormwater-related pollution are not limited to wastewater conveyance and processing. Other sources include:

- industrial discharges;
- runoff from lawn watering, car washing, and other residential activities;
- water diversions;
- runoff from confined animal feeding lots.

The solutions are as diverse as the causes for these sources, and include vigilant monitoring, consumer education, careful siting, and best management practices.

WATERSHED STEWARDSHIP PROGRAMS

Preserving the quality of a watershed is an ongoing process that needs strong support from the watershed community. Maintaining a healthy watershed includes advocacy, education, pollution prevention, maintenance of water-quality-protecting vegetation and structures, monitoring, and restoration.

Advocacy

A group with a long-term focus on and commitment to the well being of a water body and its watershed needs to be in place. This may be a citizens' group or an arm of local government, although grassroots approaches may have an advantage in their ability to engage the community. The group should form partnerships with other groups in the watershed and coordinate stewardship efforts. This group will be the watershed watchdog, always keeping the welfare of the watershed as its primary objective.

Watershed Education

Everyone is a resident of a watershed, and to be good watershed stewards, the residents need to understand both that they live in a watershed, and how to live in a watershed. The first step is to raise watershed awareness through such means as signage, storm drain stenciling (marking storm drains with a message such as "Don't Dump - Drains to River"), walks, tours, and maps. Residents need to be educated about the role that their individual behavior plays in the quality of the watershed. Special training should be offered for developers, to teach them how to use the tools of watershed protection. Opportunities for active engagement in stewardship, such as clean-up days and buffer-planting projects, should be offered.

Pollution Prevention

Pollution is always easier to prevent than to clean up. In some cases, such as industries that are required to have NPDES (National Pollution Discharge Elimination System) Multi-Sector General Permits, pollution prevention plans are required by law. Assistance in these cases may be available from state or local government. For many other businesses, pollution prevention plans are not required but may make economic, as well as environmental, sense. Training should be offered in pollution prevention methods for businesses in the watershed.

Watershed Maintenance

Many of the physical (and non-physical) tools of watershed protection require periodic maintenance to remain effective. Vegetation may need to be replanted, debris and sediment removed, sewer systems inspected, and septic tanks pumped. Non-physical tools such as plans, ordinances, and education programs need to be periodically revisited to evaluate their effectiveness as well.

Watershed Indicator Monitoring

Are watershed protection strategies working? The only way to be certain is by maintaining a regular monitoring program. This program can be performed by state or local government or by citizens' groups, but needs to be consistent to be effective.

Watershed Restoration

Watershed stewardship can go beyond maintenance of present conditions to restoration or at least rehabilitation of areas that have already been degraded. One method of watershed restoration already mentioned is pollution prevention. Another method is retrofitting of already existing structures, such as dry detention "ponds" developed for flood control, to provide a water quality control ability. Habitat enhancement, particularly where habitat has been degraded by human action, can also be regarded as a type of watershed restoration.

The Conservation Planning Approach

CONSERVATION PLANNING: BASIC APPROACH

Conservation Planning follows an approach that reverses many of the steps of conventional subdivision layout. It does not decrease the gross density, but results in clustering of activity and preservation of unique properties of the land to be developed. The process begins by identifying the environmentally unbuildable areas. These wetlands, floodplains, and steep slopes are blocked out from the planning area. In some cases, certain soils are removed as well. The second step is to identify the unique characteristics of the site. These could include forests, high quality agricultural soils, scenic vistas, or other historic or visually pleasing features. These areas are also blocked out as areas unsuitable for building in order to preserve the unique features. The next step in developing the site plan is to place the buildings on the remaining land. The final two steps consist of connecting the buildings with roads and paths and drawing the lot lines. This approach has been shown to decrease the amount of impervious surface in a given development, maintain the initial gross densities, and save money by requiring less earthwork and pavement and clustering for more efficient service delivery. Conservation planning results in clustering of activity and preservation of unique properties of the land to be developed.

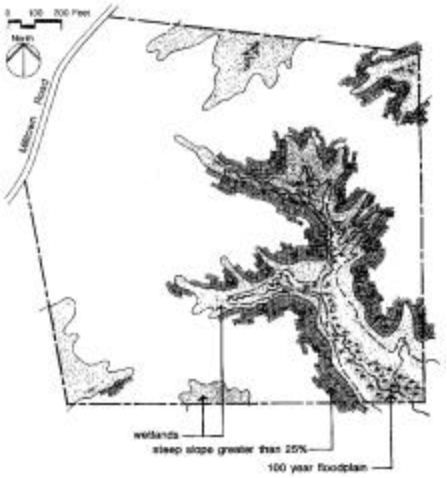


Figure A3-1: Step One – Identifying Primary Conservation Areas (Source: *Growing Greener: Putting Conservation into Local Codes*, 1997)

Figure A3-2: Step Two – Identifying Unique Characteristics. Typically unprotected under local codes, these special features constitute a significant asset to the property value and neighborhood character. (Source: *Growing Greener*)

Figure A3-3: Step Three – Locating House Sites (*Source: Growing Greener*)

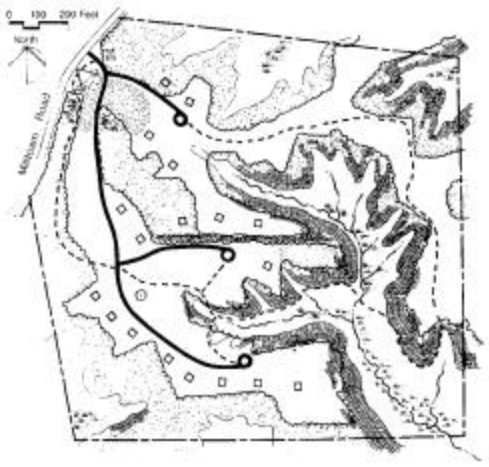


Figure A3-4: Step Four – Aligning Streets and Trails (*Source: Growing Greener*)

Figure A3-5: Step Five – Drawing in the Lot Lines (*Source: Growing Greener*)

IMPLEMENTING CONSERVATION PLANNING THROUGH COMPREHENSIVE PLANS AND ORDINANCES

Comprehensive Plans form the base for land use planning. Including the design standards for conservation planning noted earlier is important. In addition, the following can be set forth in the plan:

- An area-wide (beyond the property in question) map of potential primary and secondary conservation areas. This would imply a local government planning effort to begin area-wide conservation planning.
- Map out areas for green space in the future, acknowledging and protecting personal property rights, and include in Comprehensive Plan.
- Implementation Section of Plan should include statements articulating how conservation planning can and should be incorporated into zoning, subdivision, site plans, and other relevant ordinances.

Subdivision Ordinances should include the following components:

- A good location map of the property in relation to adjacent or affected properties in the vicinity.

- Analysis of existing resources on the site: using a topography map, locate vegetation patterns, productive soils, viewsheds, cultural landmarks, hydric soils, rock outcrops, etc. (This assists in informed decision-making)
- Site visits by the developer, planning staff, planning commissioners, and elected officials.
- Sketch plans. These are easy and relatively inexpensive and can be done on tracing paper, using above topo for base. These are considered pre-preliminary plans and are useful because they are used so early in the process there is room for adapting as the project moves into final phases. Use of a sketch plan that shows tentative locations of streets, etc. can allow the project to skip preliminary plan, which are move expensive to develop, and develop detailed plans.
- Conceptual preliminary plan. This saves time and money for the developer and avoids end runs on the process.
- Design process. Use of the four-step process should be stated clearly in the ordinance.
- A prioritized list of resources to be conserved. Some may not make the final list, and this gives a basis for discussion.
- Use overlay districts for certain significant areas such as entry corridors, watersheds, etc. Within overlay districts conservation planning guidelines may be mandated if there is a link to health, safety, and welfare of the community.

Several options are suggested to achieve open space conservation planning:

- Yield plans can be used to determine buildable lands. Require 10% sampling of lots (chosen by locality) to determine soils, percability, or other limitations on the land.
- Provide extra density for open space.
- If a developer prefers large lots, allow fewer lots to avoid sprawl along the roadside.
- Country properties could be large acre lots.

Action Agenda

Table A3.1 Action Agenda

ACTION AGENDA			
Priority	**Action Item**	**Responsible Party**	**Time Frame**
I	Accept Plan as regional plan, initiate incorporation into local comprehensive plans	Louisa, Orange and Spotsylvania Boards of Supervisors	March - Arpil 2000
I	Lake Anna Special Area Plan incorporated into local Comprehensive Plans	Louisa, Orange and Spotsylvania Boards of Supervisors	April - June 2000
IB	Review current ordinances to concur with plan, water quality protection, and for conformity with other Lake localities	Louisa, Orange and Spotsylvania Planning Commissions	July - August 2000
IA	Amend zoning ordinances to protect water quality and to be consistent with Plan and other Lake localities, incorporating "Growing Greener" conservation planning concepts	Louisa, Orange and Spotsylvania Boards of Supervisors	September - October 2000
II	Define role of Lake Anna Advisory Committee in local planning process	Louisa, Orange and Spotsylvania Boards of Supervisors	March - April 2000
IB	Establish Lake Overlay District and define development standards for the district	Louisa, Orange and Spotsylvania Planning Commissions and Boards of Supervisors	September - October 2000
III	Institute water quality monitoring for nutrients, pollutants, and heavy metals (the latter in Contrary Creek and at the dam), identifying sources of fecal contamination in "impaired" streams	Virginia Departments of Environmental Quality, Health, and Conservation and Recreation; York River Basin Council; Lake Anna Advisory Group; local environmental organizations	Begin Spring 2000, continue on regular basis; report findings annually, beginning December 2000
V	Improve road system around Lake to provide adequate lanes and bike lanes	Louisa, Orange and Spotsylvania Boards of Supervisors and VDOT	Begin with Six Year Plan, June-July 2000
	Minimize use of impervious surfaces through zoning and site planning processes	Louisa, Orange and Spotsylvania Planning Commissions and Boards of Supervisors	September - October 2000

ACTION AGENDA			
Priority	**Action Item**	**Responsible Party**	**Time Frame**
	Implement education program for water protection	Lake Anna Advisory Committee, Soil and Water Conservation Districts, Farm Bureaus, and Extension Agents	Plan January - March 2000; first sessions April - June 2000
	Hold semi-annual meetings with safety and law enforcement personnel to discuss problems and solutions	Local law enforcement, Virginia Department of Game and Inland Fisheries, Virginia Power, Lake Anna Civic Association and other neighborhood organizations, fire and rescue squads	Begin May 2000
	Allow voluntary use of "Lake Anna" address	U.S. Postal Service	June 2000
	Identify organization to seek and manage grants, hold easements, purchase land for public use	Louisa, Orange and Spotsylvania Boards of Supervisors	June 2000
	Seek funding for regional water and sewer Master Plan	PDCs	January - June 2000
	Clarify lines of authority and chains of responsibility for water quality issues	Governor, State Legislators, Cabinet	2000 - 2001
	Work with Department of Conservation and Recreation on State Park improvements	Lake Anna Advisory Committee, Louisa, Orange and Spotsylvania Boards of Supervisors	2000 – 2001

X. Appendix Four - Metals

The information on metals, which was of some concern to the Committee, is detailed and not appropriate for the Plan itself. However, given public concern about the issue of metals, the review of data and information is included in this Appendix. Additional inquiries can be made to Rochelle Garwood at the Thomas Jefferson Planning District Commission (TJPDC).

EFFECTS OF METALS

Effects of high concentrations of metals vary, but can include physical, developmental, and reproductive effects, as well as mortality at very high levels. Certain metals that are nutritionally required in small quantities, such as zinc and copper, are able to be regulated by fish, but may be toxic to other types of aquatic organisms. Other metals, such as lead, cadmium, and mercury, can be toxic to fish as well, and to other animals (including people) who eat sufficient quantities of the fish. Of the metals, only mercury bioaccumulates, but fish consumption advisories have been listed (on the Listing of Fish and Wildlife Consumption Advisories, online at http://fish.rti.org/) for other metals, particularly lead.

Metals data for Lake Anna are sparse and consist of the Virginia Power measurements, one set of surface water measurements for seven of the tributaries from DEQ, one set of sediment measurements from DEQ for each of the tributaries (two sets for three of them), and two sets of sediment measurements from DEQ for the lake. Additionally, the Virginia Power data are of limited use because surface water quality standards for aquatic life for several metals are dependent on hardness (the sum of polyvalent cations, such as calcium and magnesium, dissolved in the water - this is expressed as a $CaCO_3$ concentration), and Virginia Power did not measure hardness. No data is currently available on metals concentration in fish or other animals in Lake Anna, but the U.S. EPA has just completed sample collection for a fish tissue study (part of a random lake sampling program), which is expected to be available in the latter part of 2000.

Surface Water

Even the limited metals data available indicate cause for concern. Hardness measurements for Contrary Creek and the other tributaries in Louisa County are available for various periods during the 1990s from DEQ, and for the lake from the two sets of AWQM data in 1991 and 1996. These can be used to get a ballpark estimate of water quality standards. Hardness measurements for the lake and other tributaries are fairly similar (except for Mountain Run, which is somewhat higher), but quite different from Contrary Creek, as seen in the following table:

Table A4-1. Hardness measurements

Station	Hardness (as mg/L $CaCO_3$)		
	Low	**Mean**	**High**
Contrary Creek ('93 - '98)	44	111	320
Elk Creek ('93 - '98)	13	18	37
Goldmine Creek ('93 - '98)	19	26	36
North Fork Hickory Creek ('91 - '95)	8	20	74
South Fork Hickory Creek ('91 - '98)	10	17	82
Beaver Creek ('94 - '98)	5	13	24
Mountain Run ('94 - '98)	38	57	70
Pamunkey Creek ('94 - '98)	10	29	44
Terry's Run ('94 - '98)	15	24	34
Plentiful Creek ('94 - '98)	8	15	32
Lake ('91 & '96)	4	13	16

Because there are only a total of eight hardness measurements taken on two days for the lake, the full range of measurements for the lake and other tributaries was used to calculate water quality standards for the three metals (copper, lead, and zinc) that were measured by Virginia Power for which aquatic life water quality standards have been established. There are two sets of standards, for chronic (ongoing) and acute (one-time) conditions.

Table A4-2. Calculated Water Quality Standards

Constituent	Level		Contrary Creek	Lake/Other Tributaries
Hardness (as mg/L $CaCO_3$)	Low		44	4
	Mean		111	23
	High		320	82
Copper WQS range (µg/L)	Acute	Low	8.2	0.85
		Mean	20	4.4
		High	53	15
	Chronic	Low	5.9	0.76
		Mean	13	3.4
		High	32	10
Lead WQS range (µg/L)	Acute	Low	42	2.0
		Mean	140	18
		High	520	92
	Chronic	Low	4.7	0.22
		Mean	15	2.1
		High	59	10
Zinc WQS range (µg/L)	Acute	Low	58	7.6
		Mean	130	34
		High	310	99
	Chronic	Low	53	6.9
		Mean	120	30
		High	280	90

Annual averages of copper concentrations made by Virginia Power varied from 20 - 180 µg/L (reported as 0.02 - 0.18 mg/L) at Contrary Creek. The average over the 11-year period for Contrary Creek was about 70 µg/L; since the highest calculated WQS for Contrary Creek was 53 µg/L, it seems likely that Contrary Creek violated the

WQS for copper for the period more often than not. Annual averages of copper measurements were between 0 and 50 µg /L at the other stations. Most years' averages were 0, but 1975, 1976, 1982, and 1983 were years in which the average was greater than 0 at all stations. These averages were all either 10 or 20 µg/L, except for the dam in 1975 (30 µg/L) and the Virginia Power intakes in 1976 (50 µg/L). Additionally, the station at the intakes at Virginia Power had an average copper concentration of 10 µg/L in 1978, and the station at the dam had an average concentration of 10 µg/L in 1980. The highest single measurement cited in the Virginia Power report since 1979 was 1,100 µg/L at the Rt. 208 bridge in 1980. As shown in the preceding table, the highest calculated WQS for chronic exposure of aquatic life to copper for the lake and other tributaries was 10 µg/L, and for acute exposure 15 µg/L, so these concentrations are of concern.

Lead concentrations also seemed most likely to be high in 1975, 1982, and 1983. Contrary Creek had measurable levels of lead in five years, with annual averages ranging from 10 µg/L to 60 µg/L. Because lead toxicity varies greatly with hardness and Contrary Creek's hardness varies greatly, and because it is unknown whether the averages reflect occasional spikes of lead or chronic problems, it is difficult to evaluate how much of a problem there was. Other stations had measurable levels of lead (at least 10 µg/L, which was the highest WQS calculated for the lake for chronic conditions) in 2 - 5 of the 11 years sampled. The highest annual average by far was that of 940 µg/L at the dam in 1975; the next highest average was 70 µg/L at the North Anna arm in 1983. The highest single measurements recorded after 1979 were 380 µg/L in a surface sample at the Rt. 208 bridge in 1982, and the same concentration in a bottom sample in 1983 at the North Anna arm (undoubtedly contributing to the high average for that year). These measurements almost unquestionably violated the WQS. Lead was not detected in any of the 342 samples taken from September 1983 to the end of the study in 1985.

Annual averages of zinc concentrations more commonly exceeded 0, but because zinc standards, like lead, vary greatly with hardness, it is difficult to tell whether averages exceeded standards. Averages at Contrary Creek ranged from 30 µg/L in 1977 to 470 µg/L in 1983, and were most often around 200 µg/L, making it likely that the station often violated the WQS. For the other stations, averages ranged between 0 µg/L and 30 µg/L, and all of the stations that were used for the duration of the study had at least four years of averages at 10 µg/L or above. However, they often weren't the same four years. Both the Rt. 208 bridge and the dam stations had measurable levels of zinc seven of the 11 years, and these stations had the highest average concentrations, with 30 µg/L at the Rt. 208 bridge in 1983 and at the dam in 1983 and 1985. Zinc levels seemed more likely to be high in the latter years of the study the dam and intake stations both averaged 10 µg/L or above in each of the last six years (1980 - 1985). The highest single measurement cited in Virginia Power's report after 1979 was 1,140 µg/L at Contrary Creek in 1983.

The concentrations of metals reported indicate cause for concern, and a definite need for more testing. The individual results from the study were unavailable, and without viewing them, it is not clear whether the reported averages reflect chronic levels of metals or spikes of high metals alternating with periods during which metals concentrations were low or nonexistent. Also, Virginia Power took samples at several levels within the lake (surface to bottom), and averaged them for the report. However, high levels in the lower level of the lake during the summer (when it is stratified and not oxygenated in its lower depths) would not have as great implications for aquatic life as high levels near the surface. Also, DEQ hardness measurements were taken near the surface, and may not accurately reflect hardness at greater depths. In any case, it is difficult to be certain of the interpretation of the Virginia Power results without hardness measurements taken concurrently. Regardless of the relation of those results to water quality standards, they clearly indicate some temporal variability of metals concentrations, and no water column measurements for metals have been taken at Lake Anna since 1985.

DEQ was unable to detect copper, lead, or zinc in the surface water samples taken in September 1994 for the five tributaries in Orange and Spotsylvania Counties that they monitor. Their limits of detection were 50 µg/L for copper and zinc, and 5 µg/L for lead. Copper and lead were detected at Contrary and Goldmine creeks on July 1, 198l; additionally, cadmium was detected at Contrary Creek. In the case of Goldmine Creek the detections were at very low levels below the limits of detection in Orange and Spotsylvania, indicating the use of different equipment. Hardness measurements were not taken on July 1, 1998, but were taken on July 13, 1998; the water quality standards for those hardness measurements are shown in the following table, along with the measured concentrations of copper, lead, and cadmium.

Table A4-3. Water Quality Standards for Hardness Measurements

	Copper (mg/L)	**Lead (mg/L)**	**Cadmium (mg/L)**
Goldmine Creek measured concentration (7/1/98)	0.6	0.2	--
Acute WQS for Goldmine Creek (7/13/98)	3.7	14	--
Chronic WQS for Goldmine Creek (7/13/98)	2.9	1.6	--
Contrary Creek measured concentration (7/1/98)	250	8	3
Acute WQS for Contrary	16	103	3.4

Creek (7/13/98)			
Chronic WQS for Contrary Creek (7/13/98)	11	12	1.0

It seems likely that Contrary Creek violated the water quality standards for dissolved copper, and it may have violated them for dissolved cadmium. Of course, hardness measurements taken 12 days later may not accurately reflect the conditions at the time of the metals sampling. However, this provides another demonstration of the need for a coordinated testing program.

Sediment

Sediments do not have a set standard, but DEQ uses levels above which they consider a water body to be "threatened." These are called ER-M, or "Effect Range - Median," as they are the median of the concentration range over which metals are found to be toxic to certain bottom-dwelling organisms. The ER-M are not dependent on hardness or other external factors. The values used by DEQ for copper, lead, and zinc are shown in the table below with results for sediments in Lake Anna and its tributaries.

Table A4-4. DEQ Values

	Copper (mg/kg)	**Lead (mg/kg)**	**Zinc (mg/kg)**
ER-M	**390**	**110**	**270**
Lake Anna (100 yds above dam) 9/19/91	36	12	96
Lake Anna (upper lake) 9/19/91	49	36	160
Lake Anna (100 yds above dam) 6/25/96	47	24	286
Contrary Creek 8/1/96	1198	157	96
Elk Run 8/1/96	41	160	21
Goldmine Creek 8/1/96	8	9	30
S. Fork Hickory Creek 8/1/96	undetected (<5)	5	9
Beaver Creek 6/16/97	6	10	30

Mountain Run 6/26/95	12	13	10
Mountain Run 6/16/97	14	11	44
Pamunkey Creek 6/29/95	7	7	undetected (<5)
Pamunkey Creek 7/1/97	28	10	33
Terry's Run 6/29/95	41	16	42
Terry's Run 7/1/97	24	23	131
Plentiful Creek 6/26/95	undetected (<5)	6	undetected (<5)

Contrary Creek sediments measured above the ER-M for lead, and well above the ER-M for copper. Lake Anna sediments near the dam measured above the ER-M for zinc. Given surface water quality testing results, neither of these results is very surprising, although certainly of concern. More surprising is the finding that Elk Run sediments also measured above the ER-M for lead. Unfortunately, there are no other data for Elk Run to help determine whether this indicates a problem or was simply an anomaly due to contaminated equipment or the like. Again, a regular testing program for metals, in conjunction with hardness measurements for surface waters, is needed to determine the extent of the problem. A metals concentration problem seems likely in Contrary Creek. Whether it extends beyond is a question that needs to be answered.